

Repair Manual en

RRE140/160/180/200/250

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2 – General introduction

2.1 How to use the manual

The service manual is divided into chapters containing the following information:

- Functions and parameters – This chapter contains a basic description of the main functions of the truck and the control system parameters.
- Installation and initial operation – This chapter describes the work that needs to be done before the truck is used for the first time.
- Maintenance – This chapter contains a general periodic maintenance schedule and a detailed description of the maintenance to be carried out.
- Troubleshooting – This chapter describes the error codes that appear in the display when the truck completely or partly stops working. The chapter also describes the reason why the errors occur and suggested remedies.
- Step by step – This chapter describes the various parts of the truck, for example the hydraulic system, including what the parts look like and the service activities that need to be carried out. The various descriptions are organised according to BT's C-code system.
- Appendixes – The appendixes contain:
 - instructions for disposal
 - information about electrical components and wiring diagrams
 - hydraulics diagrams
 - list of required tools
 - information about general tightening torques
 - oil and grease specifications
 - Technical data.

General introduction

Warning symbols

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815, 816

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2.2 Warning symbols

The following warning symbols are used in the service manual:



DANGER!

*The word **DANGER!** means there is a risk of accident potentially leading to death or serious injury and material loss or damage. Always accompanied by the warning symbol.*



WARNING!

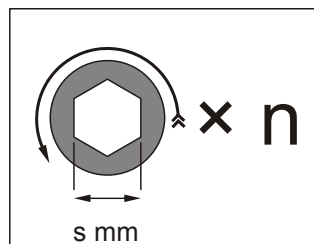
*The word **WARNING!** means that there are components sensitive for electro-static discharges. Follow applicable ESD-routines to protect the device.*

IMPORTANT

*The word **IMPORTANT** means there is a risk of material loss or damage if the instructions are not followed. Also used to draw attention to a non-standard torque.*

2.3 Pictograms

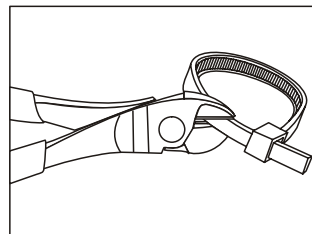
Where suitable, pictograms are used to describe some actions. Mainly this applies to the release and fastening of screws:



The pictogram gives information about type of screw head and turning direction indicated with an arrow.

Additional text below the pictogram gives information about 's': key size, 'n': number of screws and, where applicable, recommended torque.

One example of another pictogram type is "Cut tie wrap":



The pictogram might have additional information below, saying how many ties to cut.

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3 – General safety rules

Only personnel trained in servicing and repairing this type of truck are authorised to carry out service and repair activities.

3.1 Safety while working

To ensure that you work safely and to prevent accidents while working on a truck, remember the following:

- keep the area where servicing activities are performed clean. Oil or water will make the floor slippery.
- use the correct working position. Service activities often involve kneeling or bending forward. Try sitting on a toolbox, for example, to relieve the strain on your knees and back.
- loose articles and jewellery may become trapped in the moving parts of the truck. So never wear loose articles or jewellery while working on the truck.
- use the correct tools for the work you are carrying out.
- keep all tools well maintained.
- store and transport old oil according to applicable local regulations.
- do not flush solvents, etc. down the drain unless they are intended to be disposed of in this way.

Follow the local disposal regulations.

- heated paint gives off harmful gases. So use sanding or a paint stripper to remove the paint at least 100 mm around an area where any welding/grinding is to take place.

General safety rules

Electrical system

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3.2 Electrical system

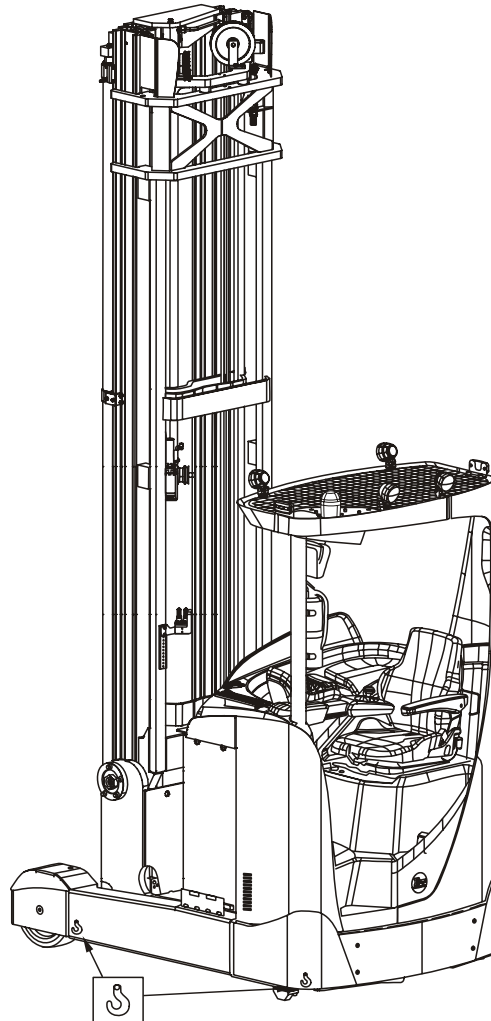
When working on the electrical system of the truck, remember the following:

- a short circuit may occur if metal objects come into contact with live connections. This can result in burns. So remove watches, rings and other metal jewellery before starting work.
- always use insulated tools while working on the electrical system.
- always switch off the truck's power supply before opening the hoods to the drive assembly and the electrical system.
- disconnect the battery when using electric welding equipment. The welding current may damage the battery.
- always remove the battery plug when carrying out maintenance on the truck, unless the instructions in this service manual state otherwise.
- blow electric motors clean using compressed air.
- clean electrical panels, electronic cards, connectors, contactors, solenoid valves, etc. with a moist cloth and a cleaning agent that will not damage the part.

IMPORTANT

***Risk of short-circuiting that may damage electrical components.
Do not break the warranty seal on the electronic cards.***

3.3 Safe lifting



All lifting must be carried out on a flat, nonslip and stable surface. Asphalt floors must be avoided if possible.

- To prevent the truck moving while it is being lifted, it must not be lifted with anyone on the platform or with the tiller arm in the lowered position.
- If the drive wheel, which is braked, is being lifted the other wheel must be chocked to stop the truck moving.
- Select the lifting point so that the lift is as light as possible, for example one corner at a time. If the truck has marked lifting points on the lower part of the chassis, these should be used for a well-balanced lift.
- Ensure the area where you place the jack is clean and free of oil and grease.
- Ensure there is no grease or oil on your hands or the jack lever.

General safety rules

Safe lifting

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- Use the lever supplied with the jack. If the lever is too short, it will require more effort than is necessary. If the lever is too long there is a risk that the jack will be overloaded.



DANGER!

Risk of crushing – a poorly chocked truck may fall.

- **Never work under a truck that is not blocked with supports or secured by a lifting device.**
- Place supports:
 - as close to the raised part of the chassis as possible to reduce the falling height if the truck tips over
 - so that the truck cannot roll.
- **Never** place a support under the jack to increase the lifting height.
- **Never** work under a lifted truck without appropriate supports.

4 – Functions and parameters

4.1 Chassis 0000

4.1.1 Driver protection (0840)

Tilt stops

To increase truck capacity, tilt stops are fitted to some trucks. Tilt stops are also available as an option.

It is, however, permissible to temporarily remove tilt stops when transporting the truck, between different warehouses, for instance; but the truck may not in this case be used to transport loads.



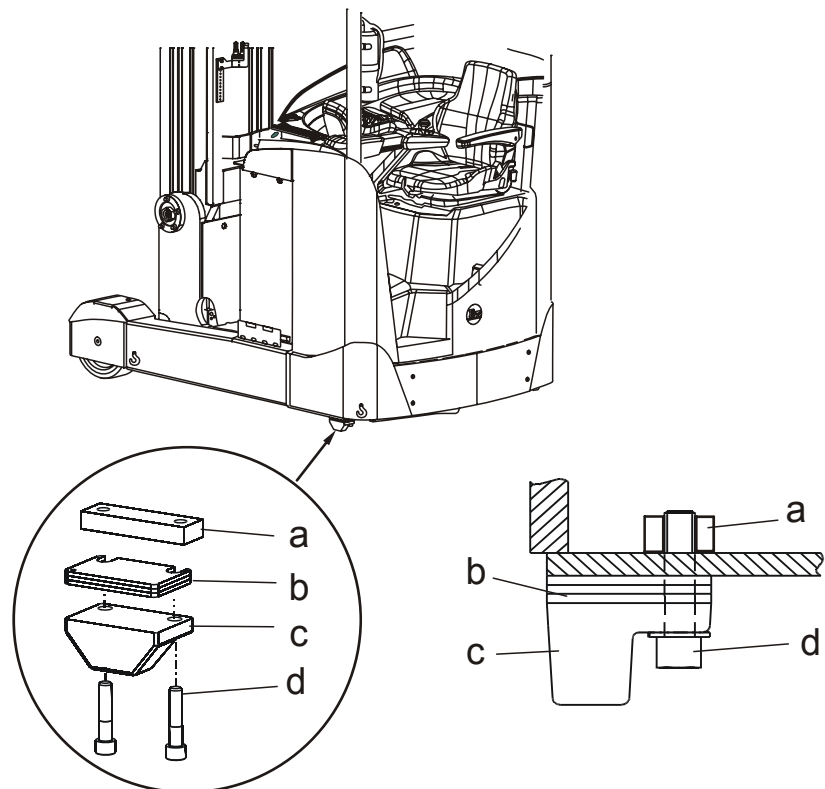
WARNING!

Reduced stability.

Trucks without tilt stops can tip over, if used to transport loads.

Ensure that tilt stops are refitted at the correct floor distance if they have been temporarily removed.

The tilt stops are located on the rear corner of the support arm and consist of stops (c), shims (b), bolts (d), and nuts (a) on the inside of the chassis.



Functions and parameters

Chassis 0000

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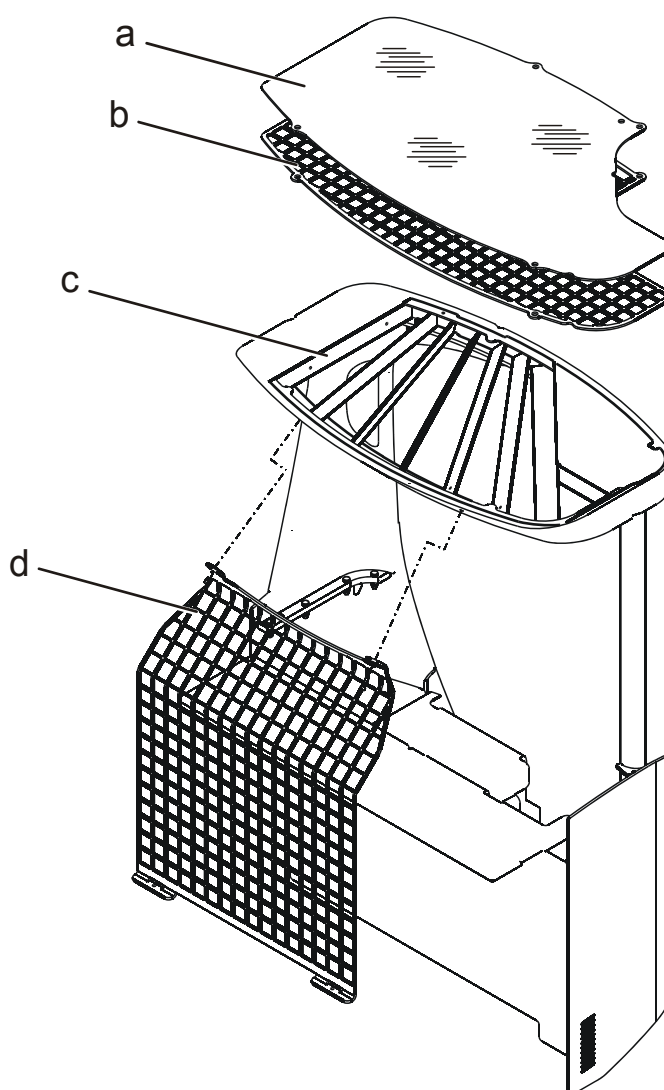
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Overhead guard

The cabin is protected from falling objects by a casing with bars (c) bolted into the roof of the cabin shell.

The casing can be supplemented by a guard of finer mesh (b) and a transparent top (a).

The truck may be fitted out with a protective grating (d) between the cabin and the mast.



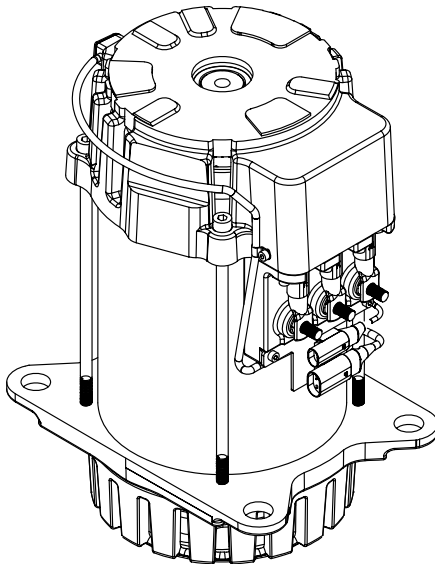
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4.2 Motors 1000

4.2.1 General

The truck motors are the drive motor, the pump motor for the hydraulics, and the steering motor for rotating the drive unit (steering).

The drive and pump motor are three-phase AC motors. The steering motor is a brushless DC stepper motor. The voltage for all motors is 48 Volts.



4.2.2 Electric pump motor (1710)

General

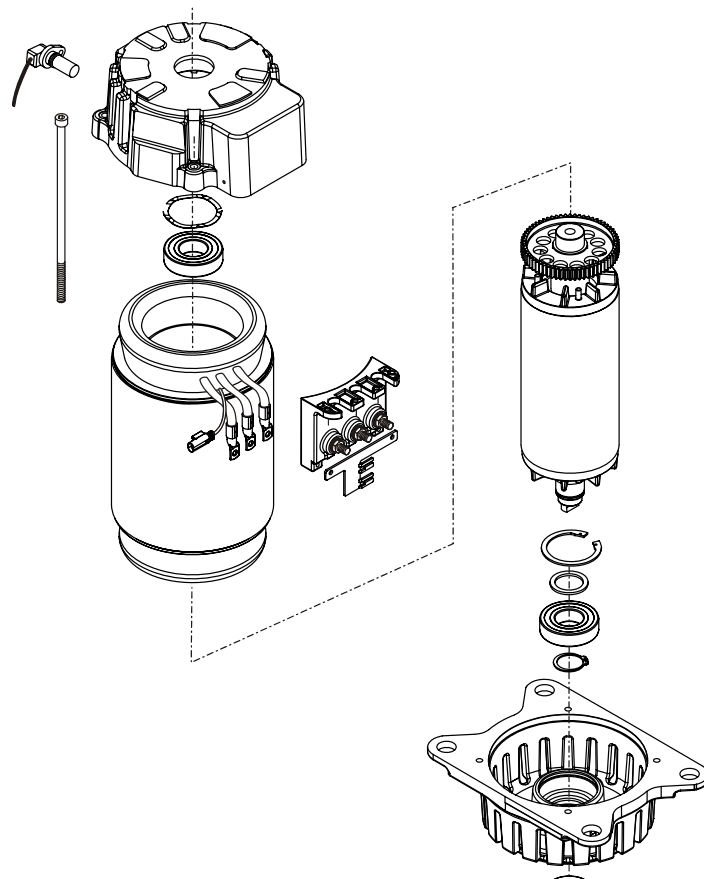
The pump motor is a three-phase AC motor. In the motor, there is a thermoelement that measures the motor temperature, as well as a cog with a sensor for measuring rotational speed and direction.

There are two sizes of pump motor for the trucks.

On RRE140—RRE160, TSA170-200-106 is used.

On RRE180—RRE250, TSA170-180-072 is used.

Design



Functions and parameters

Motors 1000

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4.2.3 Electric steering motor (1730)

General

The steering motor is located on the drive unit housing. It receives signals from the pulse generator located in the steering column. The steering motor is equipped with a gear wheel working directly on the gear rim of the drive gear.

There are two sizes of steering motor.

On RRE140–RRE160, 247454-001 is used.

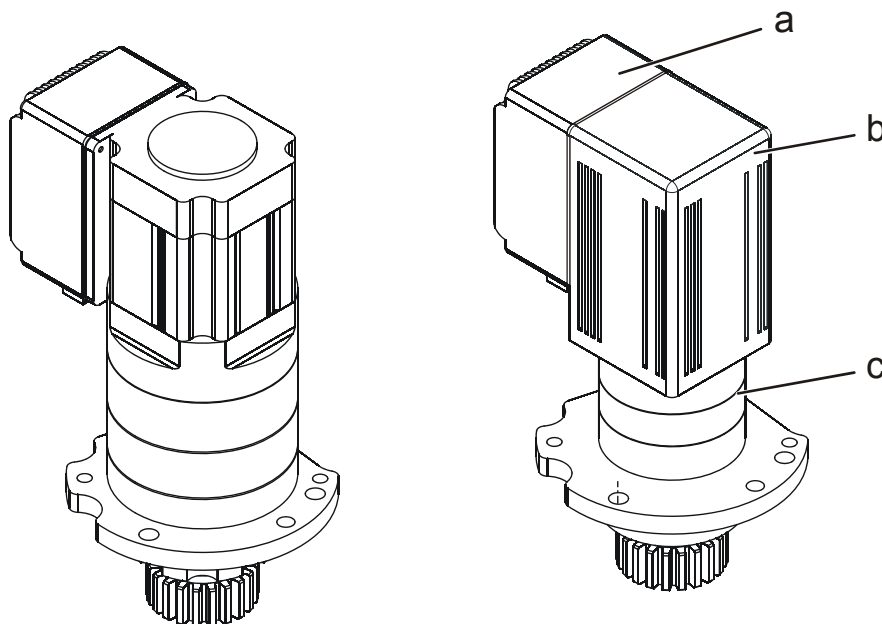
On RRE180–RRE250, 208014-003 is used.

Design

The steering motor has the EPS electronics fitted directly on top of it (a).

The motor (b) is a brushless synchronous motor with permanently magnetised rotor.

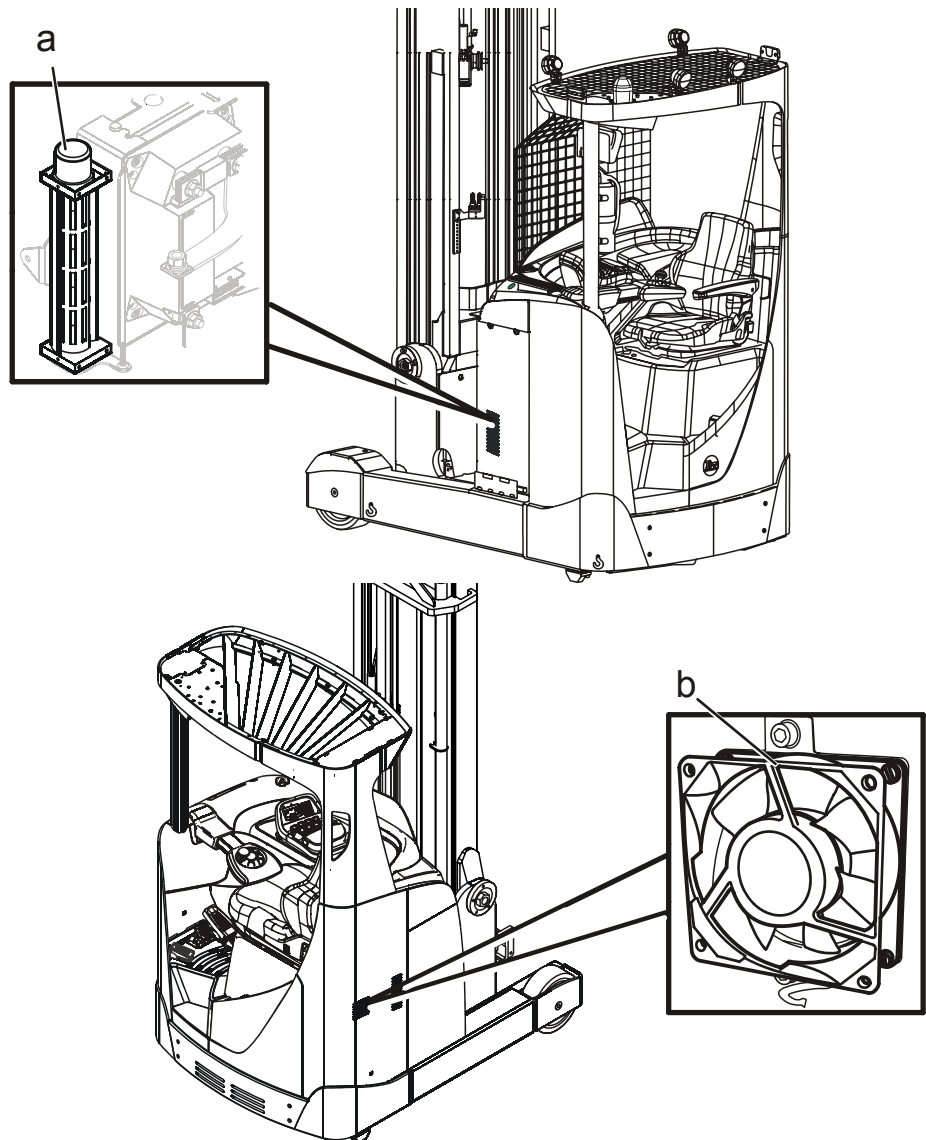
The steering motor is integrated with a two-stage planetary gear (c) that has a gear wheel on its output shaft in direct contact with the gear rim on the drive gear.



4.2.4 Fan motor/fan (1740)

There are two cooling fans in the truck's motor compartment.

These are a radial fan (a) that cools the frequency converter of the motors, and an axial fan (b) that ventilates the entire motor compartment.



Functions and parameters

Motors 1000

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4.2.5 Electric drive motor (1760)

General

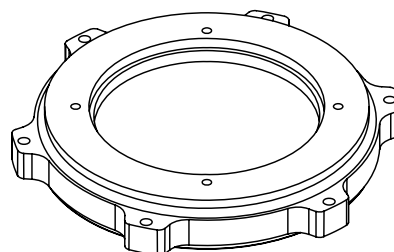
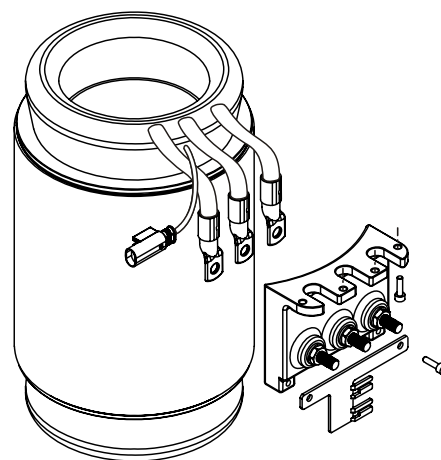
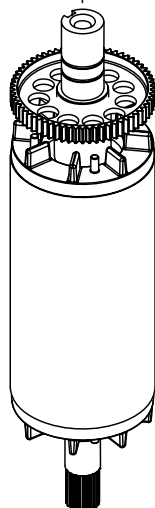
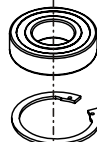
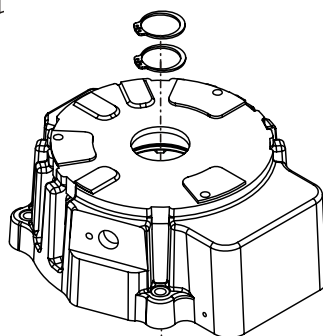
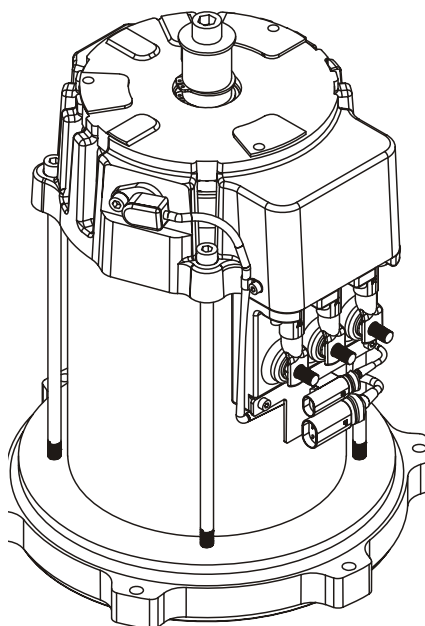
The drive motor is a three-phase AC motor. In the motor, there is a thermoelement that measures the motor temperature, as well as a cog with a sensor for measuring rotational speed and direction.

There are two sizes of drive motor for the truck.

RRE140–RRE160 uses TSA 170-200-073.

RRE180–RRE250 uses TSA 280-180-100.

Design



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4.3 Drive gear – 2000

4.3.1 General

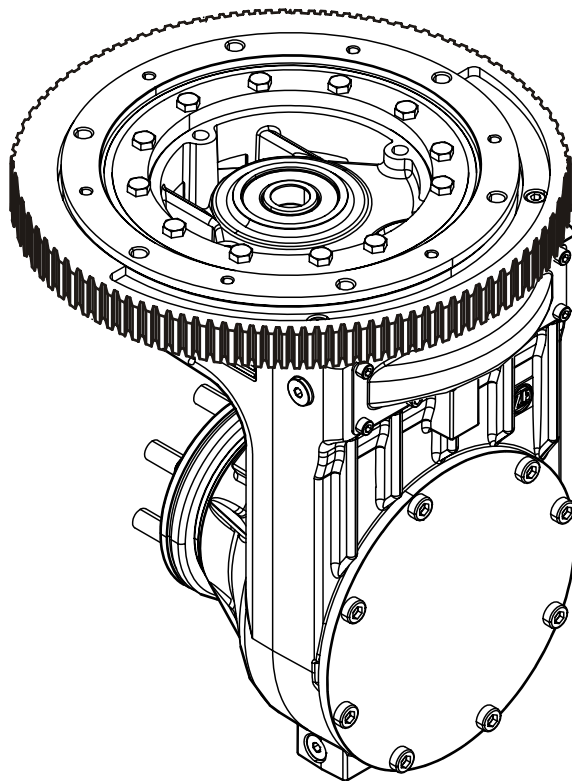
The drive gear is integrated with the motor and brake to form a complete drive unit that can be steered through 360°.

The gear is a two-stage 90 degree gear and comes in two different sizes, depending on the truck model.

- RRE140–RRE160 has a GK25 gear and
- RRE180–RRE 250 has a GK30 gear.

The drive unit is fitted to the chassis by means of 6 bolts. The steering bearings and a gear rim for the steering motor are fitted in the top edge of the gear.

The drive unit has a sensor for measuring the steering wheel direction and direction of travel.



Functions and parameters

Drive gear – 2000

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4.3.2 Design

The drive gear is a two-stage 90 degree gear with conical roller bearings on the drive shaft and pinion. The bearings are pretensioned to reduce the risk of play in them.

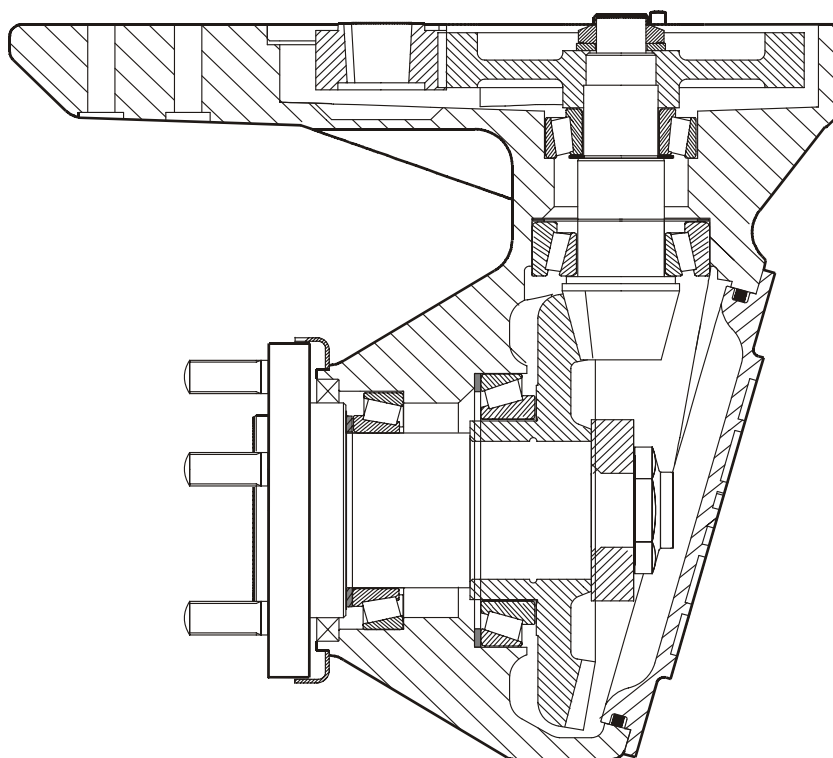
The input shaft has splines that are engaged by the drive motor's output shaft.

The steering bearing is screwed into the drive gear and can easily be replaced once the drive motor has been removed.

The gear rim is screwed into the gear and can be replaced once the drive gear has been removed from the truck.

The output shaft has a hub for the wheel. The wheel bolts are stud bolts that can be replaced.

The gear has two oil level plugs for checking/topping up the oil level. The oil in the gear should not normally be changed.



Drive gear, cross-section view

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4.4 Brake system 3100

4.4.1 General

The truck has three different types of brake:

- Travel brake
- Parking brake
- Emergency brake

Travel brake

The travel brake consists of two different systems:

- Regenerative motor braking using the drive motor
- Two electromechanical multiple disc brakes fitted in the support arm wheels (option)

Parking brake

The parking brake is made up of a single stage electromechanical disc brake fitted on the drive motor and which is engaged by means of spring pressure. The parking brake is released electrically (DC voltage).

The parking brake is activated/is active as follows:

- The parking brake is activated automatically when the truck has been stopped while being driven and the brake pedal is depressed with the truck stationary. The brake is released when the accelerator is depressed.
- The parking brake is activated automatically with a few seconds delay when the operator leaves the truck.
- The parking brake remains active after the main power has been switched on.

Emergency brake

Emergency braking of the truck takes place in the event of a fault with the steering system or a serious fault in the electrical system.

The parking brake on the drive motor is the main emergency brake.

Motor braking can operate during emergency braking provided there is a supply voltage. If there are support arm brakes on the truck, these are also engaged during emergency braking.

Functions and parameters

Brake system 3100

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4.4.2 Drive motor brake (travel brake)

The truck is braked primarily by means of regenerative braking using the drive motor. Motor braking can be obtained in three different ways. These are:

- Releasing the accelerator when the truck is in motion
- Changing the direction of travel using the travel direction selector, at the same time as depressing the accelerator
- Depressing the brake pedal

Accelerator released

The regenerative motor brake is automatically engaged when the accelerator is released. The brake force can be adjusted using an operator parameter - see section "2 – Parameters".

The motor brake force is regulated to allow for the current speed and the extent to which the accelerator is released. This works as follows:

- Braking at a high speed, with the accelerator fully released, results in high brake force.
- Braking at a low speed, with the accelerator fully released, results in lower brake force.
- Braking at a high speed, with the accelerator half released, results in medium brake force.

Changing the direction of travel

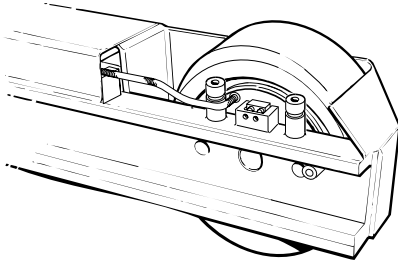
When the direction of travel is changed during operation, the motor brakes the truck so that the direction of travel can be changed. Here motor braking is regulated by the position of the accelerator - the further the pedal is depressed, the greater the force involved in braking.

The brake force for a change in direction of travel can be adjusted using a service parameter - see section "2 – Parameters".

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4.4.3 Multiple disc brake, support arm (travel brake)

General



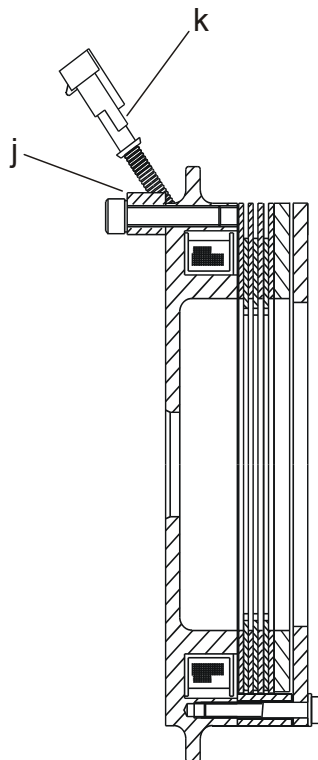
The brake is an electromagnetic multiple disc brake with multiple steel discs.

The brake is engaged by energising the magnetic coil. The current in the magnetic coil is regulated by a potentiometer in the brake pedal, resulting in regulation of the brake force.

The brake acts as a secondary travel brake, along with motor braking, and is engaged when the operator needs to brake hard, when the brake pedal is depressed through more than 50 %.

Design

The brake is fitted in the support arm wheels on a hub with splines and a locking shoe (j) which takes up the braking force.



Functions and parameters

Brake system 3100

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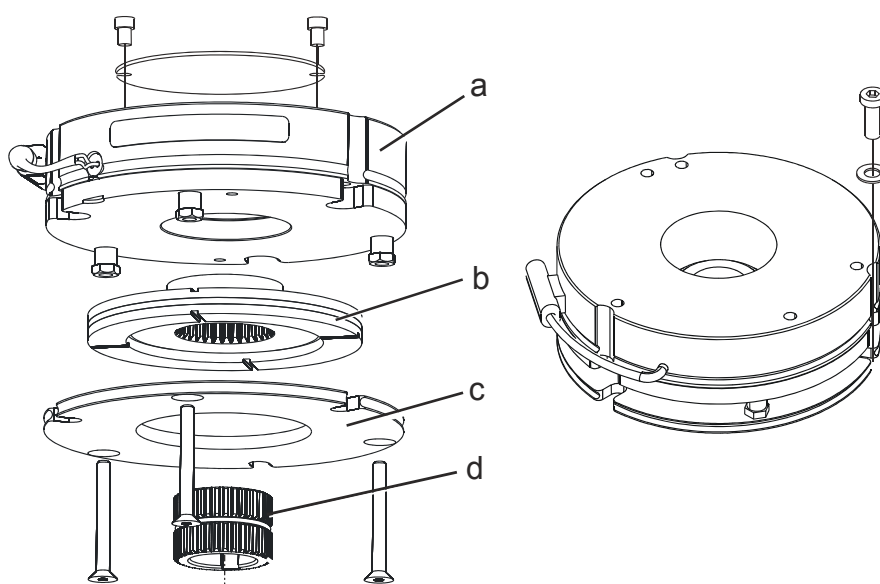
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4.4.4 Disc brake on the drive motor (parking brake)

General

The brake is a single stage electromechanical spring-loaded brake that is released when the magnetic coil is energised. Polarity does not affect its operation. The brake acts as a parking brake, as well as an emergency and secondary travel brake at the end (final 10 %) of brake pedal travel.

Design



Item	Component
a	Magnet housing
b	Brake disc
c	Friction disc
d	Hub

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4.5 Steering system 4000

4.5.1 General

The steering system is fully electric – what is known as a steer-by-wire system. As a result, there is no mechanical contact between the steering wheel and the steering drive wheel.

The steering wheel on the steering column is fitted directly to a twin pulse generator. Rotating the steering wheel results in an electrical signal, a pulse train, being transmitted to the following units:

- CID (Central Information Display), and on to
- MCU (Main Control Unit), and then to
- EPS (Electrical Power Steering), the electronics unit on the steering servo motor.

Steering is progressive, which means that when the truck is operated at low speed the steering wheel gearing ratio is higher than at high speeds. This allows the truck to be operated in a safe and efficient manner.

Design

The pulse generator in the steering wheel is connected to the CID (A1), and data is sent via the CAN1 bus to the MCU (A5). In the MCU, incoming data is logically processed to give the required response. Once processing is complete, the data is sent via CAN2 to the EPS (A2), which then makes the wheel rotate.

The EPS is fitted directly on top of the steering servo motor. The motor has a power booster in the form of a two-stage planetary gear. The planetary gear's output gear wheel is in constant contact with the gear rim on the drive gear.

The CID monitors the pulse train from the steering wheel. Monitoring is continuous, so that any break in the cabling is detected immediately. The MCU monitors the EPS and CAN buses, so any electrical faults in the pulse generator, cables or electronic unit result in automatic shut-down of the truck drive function.

Functions and parameters

Operator compartment

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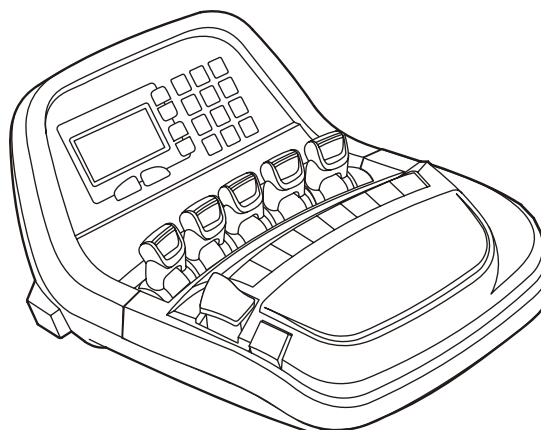
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4.6 Operator compartment

4.6.1 Truck control, overview

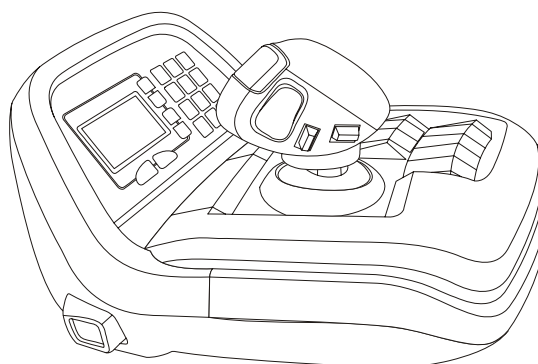
Right-hand control panel, single control

The control panel contains the controls for all hydraulic functions, travel direction and signals. The information display and keypad allow access to the truck.

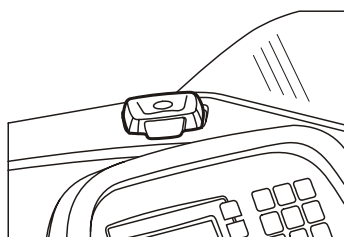


Right-hand control panel, multi-control

This has the same functions as single control, but they are located differently.



Emergency switch off



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When the emergency switch off is depressed, the main contactor [Q10] is opened, and this is indicated on the truck central information display.

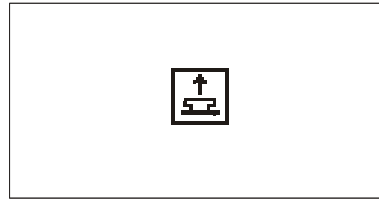


Warning!

Risk of short-circuiting.

The truck battery circuits are still live even if the emergency switch off is depressed.

When working on the electrical system the battery must be mechanically disconnected.

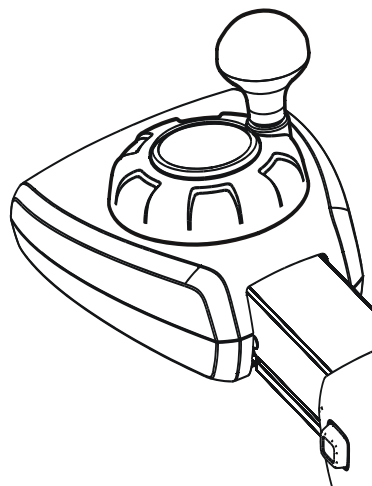


Indication on the Central Information Display on a login attempt with the emergency switch off depressed.



Indication on the Central Information Display when the emergency switch off is depressed and the truck is in logged-in mode.

Steering module



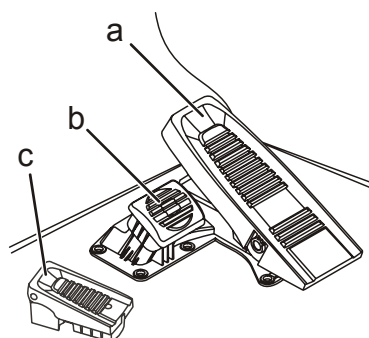
The steering module is used to steer the truck.

Functions and parameters

Operator compartment

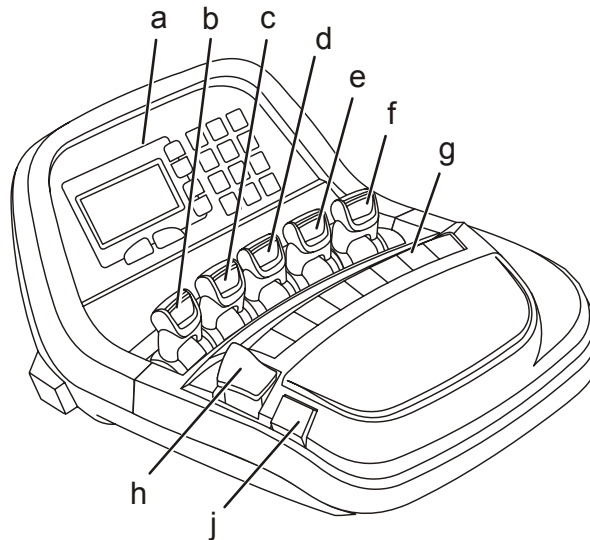
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Pedals



The truck has three pedals: a – Accelerator, b – Brake pedal, c – Safety pedal for presence checks.

4.6.2 Single control



a: CID Central Information Display.

b: Fork lift/lower.

c: Fork carriage reach/retraction.

d: Tilt.

e: Extra function 1 (sideshift, for example).

f: Extra function 2 and 3 (forkspread, for example).

g: 8 buttons for selectable functions (parameter settings).

Function examples:

- Height preselector.
- Height limitation override. The function is active for 5 seconds, and if the the first height limitation is passed, the next one applies.
- Horizontal tilt position.
- Sideshift zero position.
- Selection of extra hydraulic function 3 (active as long as the function is used and for 15 seconds afterwards) or switching detected by service parameter.
- Operator cabin tilt.
- Turn signal lights.

h: Travel direction selector.

j: Horn.

Functions and parameters

Operator compartment

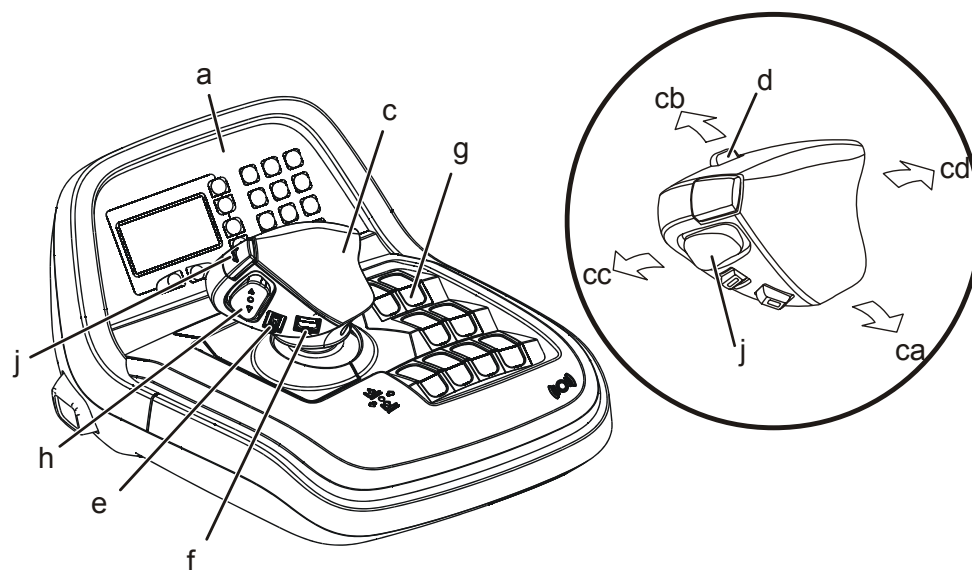
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4.6.3 Multi-control



a: CID Central Information Display

c: Multi-control

ca: Fork lift

cb: Fork lowering

cc: Reach carriage - in

cd: Reach carriage - out

d: Tilt

e: Extra function 1 (sideshift, for example)

f: Extra function 2 and 3 (forkspread, for example)

g: 8 buttons for selectable functions (parameter-based)

Function examples:

- Height preselector.
- Height limitation override. The function is active for 5 seconds, and if the first height limitation is passed, the next one applies.
- Horizontal tilt position.
- Sideshift zero position.
- Selection of extra hydraulic function 3 (active as long as the function is used and for 15 seconds afterwards) or switching detected by service parameter.
- Operator cabin tilt.
- Turn signal lights.

h: Travel direction selector.

j: Horn.

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4.6.4 Central Information Display – CID

The Central Information Display, referred to from now on as “CID”, with its menu-based information system, is used as the main instrument of communication between the operator and the truck.

The CID contains coloured LED symbols and a monochrome graphics display. At the right of the display there is a keypad with the figures 0 to 9 and the buttons "green" (I) and "red" (O).

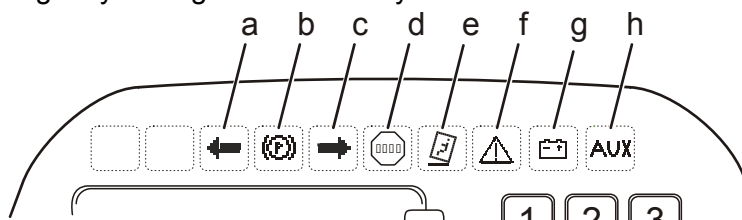
In logged-out mode the display backlighting is switched off if there has been no activity for 5 minutes. Once the keypad is activated, the lighting is switched on again.

In logged-in mode, the display is always lit.

CID LED symbols

Once the truck is started, the LED symbols of the display come on for a short time and then go out again.

In emergency driving mode all the symbols flash simultaneously.



- a. Travel direction - left.
Flashes when no travel direction is selected, comes on permanently when travel direction is the same as drive wheel direction.
- b. Parking brake.
Comes on when the parking brake is engaged.
- c. Travel direction - right.
Flashes when no travel direction is selected, comes on permanently when travel direction is the same as fork direction.
- d. Stop.
The truck has been stopped due to a critical fault.
- e. Cabin tilt.
Cabin tilting is possible (RRE Ergo)
- f. Warning.
Comes on when a warning is active.
- g. Low battery.
Battery capacity is low: flashing lamp when 10 % remaining, comes on permanently at 0 %.
- h. Extra.
Comes on when an extra hydraulic function is selected.

Functions and parameters

Operator compartment




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CID information symbols in the display area

Symbol	Description	Symbol	Description
	Truck Reach carriage fully retracted.		Truck Reach carriage fully or partly extended. Five-stage indication.
	Battery status 8 levels of charging are indicated. Completely full = Fully charged.		

Symbol	Description	Symbol	Description	Symbol	Description
	Information mode		Hour meter.		Time. Date, time and hour meter.
	Operator. Indicates the active operator profile.		Program version.		
Login					
	Login method Login with PIN code		Login method PIN code login verified by T.W.I.S.		Login method Login via ID unit or unit connected to the MCU
	Reading ID unit. Waits for identification via ID unit				
Height preselector.					
	Height preselector active		Pick up		Deposit
	Delete height				

CID disable indications in the display area

Sym- bol	Description	Sym- bol	Description
	Height limit. The lift height limit has been reached.		The travel speed has been reduced via the input to the MCU. The reduction is parameter-based.
	Function reactivation. Reactivation of the requested function is required to be able to use the truck.		Seat switch. The truck cannot be used as the seat switch has not been activated.
	Safety pedal. The truck cannot be operated as the presence check has not been activated.		Temperature. The temperature in the transistor regulator for the drive or hydraulics is over 85°C.
	ESO (Emergency Switch Off) The emergency stop button has been depressed.		Service. Time until the next service. The service interval is set with parameter 101.
	Looking for reference sensor. None of the reference sensors read.		Looking for lower reference sensor. Sensor [B58] for lower lift reference not read.
	Looking for upper reference sensor. Sensor [B46]/[B57] for upper lift reference not read.		Main lift started. The indication is displayed when attempting to drive at >4 km/h with the main lift mast raised. Travel speed is limited to 4 km/h.
	Cold store cabin – Door open. Driving disabled or limited to 2.5 km/h. Controlled by parameter 116.		

Functions and parameters

Operator compartment

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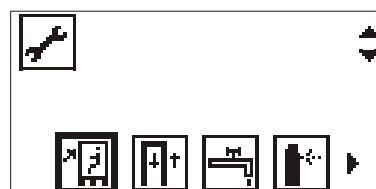
CID service symbols in the display area

Service symbols may be displayed either as a possible selection for accessing a service function or as an indication of an active service function.

Most service symbols require connection of the CAN key or TruckCom for them to be displayed.



The "Service" icon is selected in information mode, and it is indicated by a double border. The function is activated by pressing the green button.



Once the "Service" function has been activated, the service symbol appears in the top left-hand corner of the display.

Sym- bol	Description	Sym- bol	Description
	Bleeding Service function for main cylinder bleeding.		Cabin tilt Service function for tilting the cabin.
	Configuration Setting the calendar/ time, parameters and PIN functions		Impact sensor Read-out of the impact sensor log.
	Diagnostics Service and fault finding		Error log Read-out of the error log.
	Factory setting Resets the operator parameters to their basic settings		Fan test Service function for testing the fans
	PIN code Programming PIN codes		Calibration Service function for calibrating sensors, etc.
	Joystick Calibration of joysticks		Mast Service function for operating the mast.

Functions and parameters










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Sym- bol	Description	Sym- bol	Description
	Parameters Settings of the operator and service parameters.		PIN code, disable Enable or disable PIN code blocks.
	PIN code Changing PIN codes.		Pressure relief Service function for manual relief of hydraulic pressure.
	Sensor Service function for calibrating sensors.		Service Access to service mode or indication that the truck is in service mode.
	Transition Calibration of the transition function between free lift and main lift.		Valve Calibration of proportional valves.
	Load Calibration of the fork load measurement.		

Driver parameter symbols

Sym- bol	Description	Sym- bol	Description
	Steer progressiveness		Top speed – Drive wheel direction
	Top speed – Fork direction		Acceleration
	Auto brake		Cabin tilt

Functions and parameters

Operator compartment

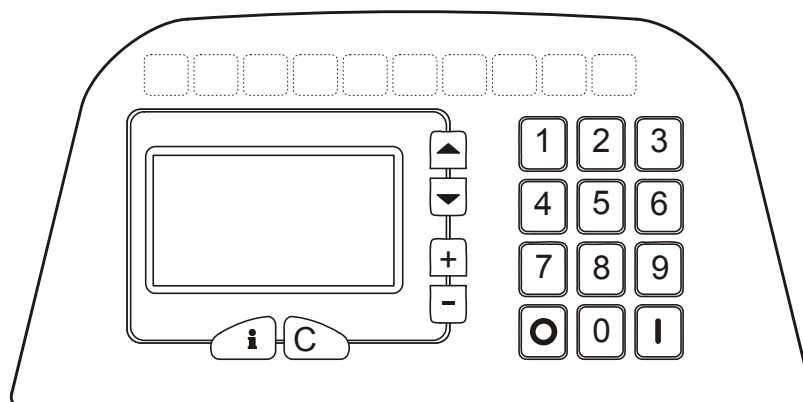
T-code
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Navigation

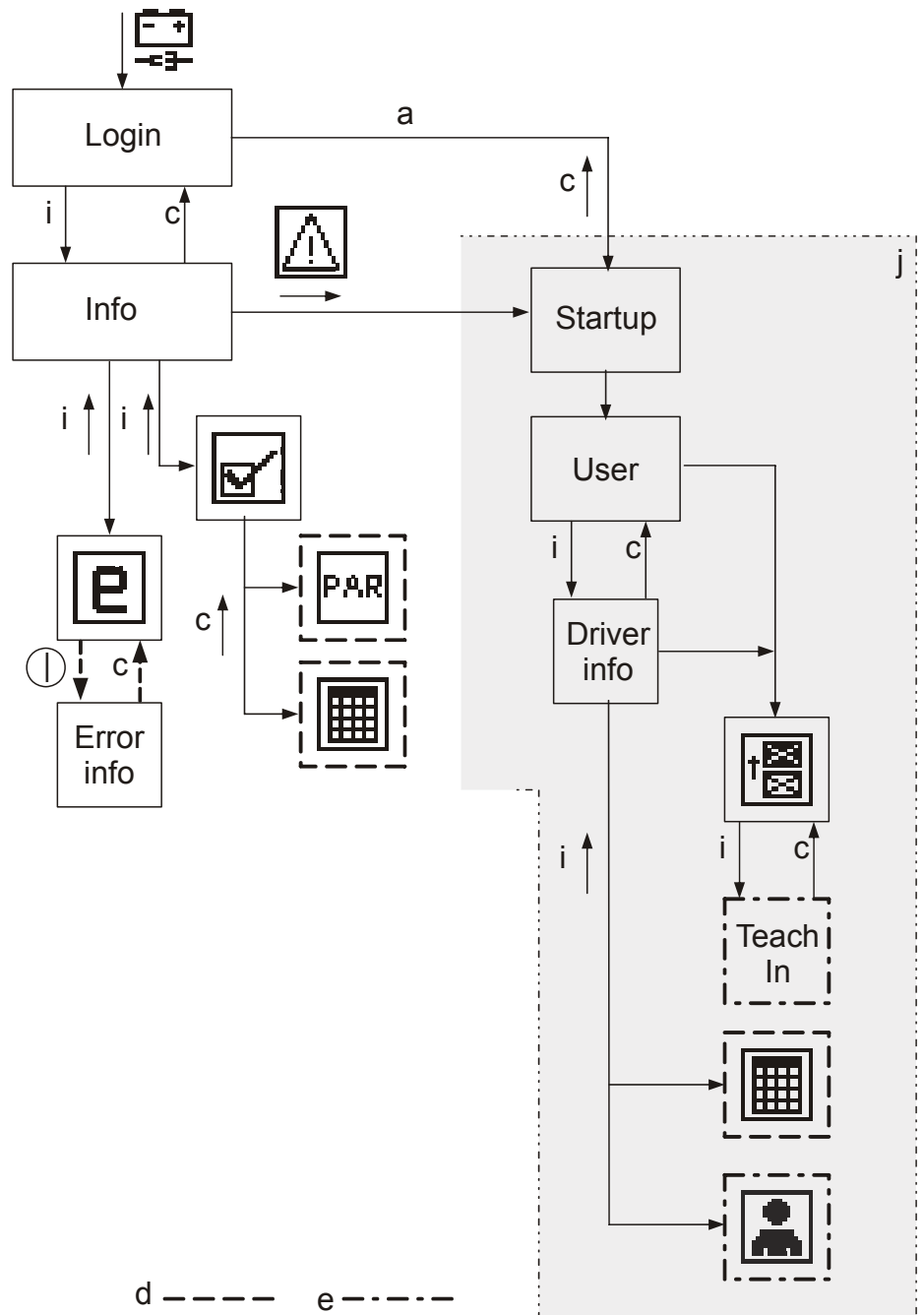


For menu navigation there are buttons with arrows, plus/minus (+/-), 'i' and 'C'.

To select an icon press on the up/down arrow until the icon for the function you require is highlighted by having a bolder border around it. Then press the green button (|) to select your chosen menu.

The C-button is used to move up through the levels, and the i-button is used as a shortcut to the information screen or to the operator information menu, depending on whether the truck is in logged-in or logged-out mode.

When logging in without the CAN key or TruckCom, only a limited number of functions are accessible and only icons for accessible functions are displayed.



Overview of the functions that are accessible without the CAN key or TruckCom.

a: Login procedure, d: Only read access
e: Parameter-based access, j: Logged in

Functions and parameters

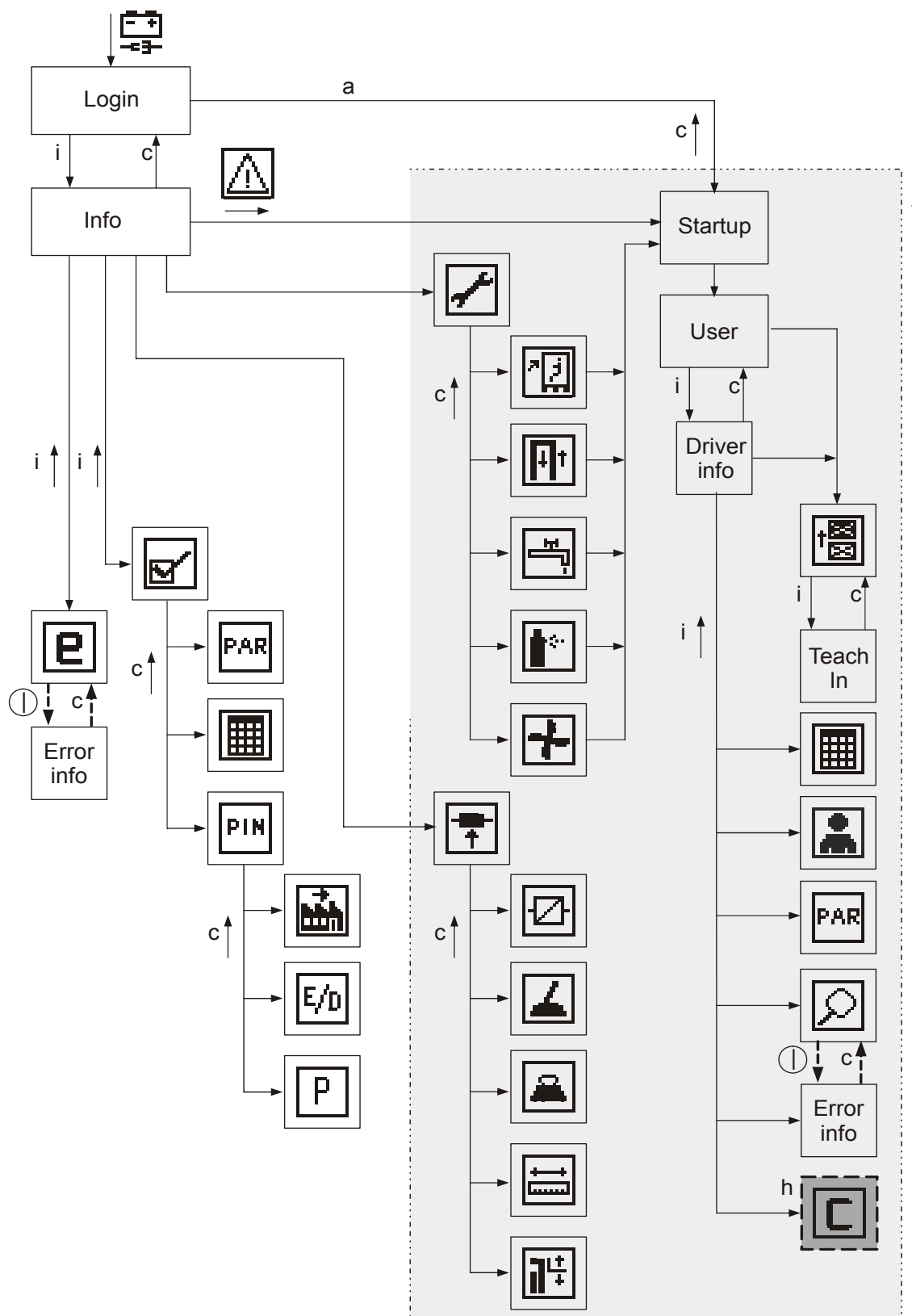
Operator compartment

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Overview of the functions that are accessible with the CAN key or TruckCom.

a: Login procedure, j: Logged in,

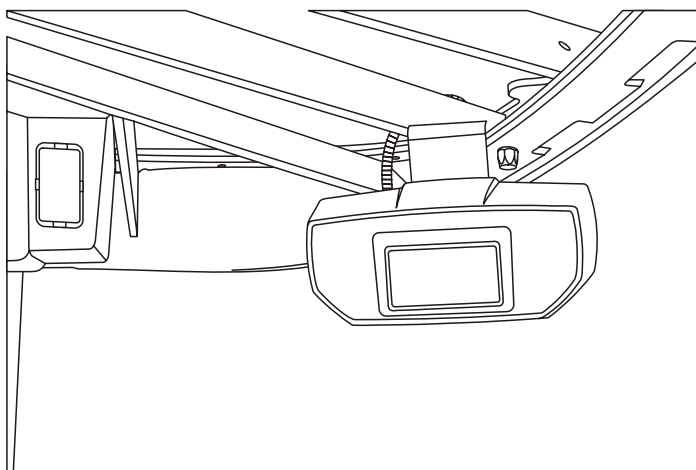
h: Also accessible with special PIN code

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4.6.5 Load Information Display – LID (option)

The Load Information Display, referred to from now on as “LID”, is available as an option and is fitted in the truck's roof panel.

If a LID is installed, it is activated on the basis of parameter settings.

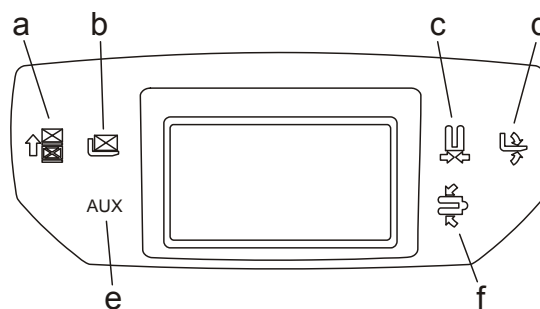


The display contains six coloured icons and a monochrome graphics display.

In logged-out mode, the display is switched off.

LID LED symbols

The coloured icons come on in the event of the following:



- a. Height preselector active (green).
- b. Not used.
- c. Sideshift in initial position (green).
- 4. Tilt in initial position (green).
- e. Aux (yellow).
- f. Not used.

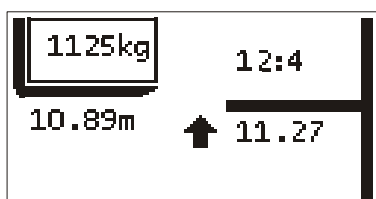
When the truck is operated in emergency driving mode, all the symbols flash simultaneously.

Functions and parameters

Operator compartment

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LID symbols in the display area



1125 kg: Load weight, 10.89 m: Load height, Right-hand half: Height preselector (option).

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4.7 Operation and connection sequences

Event:	1. Battery is connected
Action(s)	The battery [G1] is connected [X3] or, with battery replacement cables, [X1]
Contributing factors	Main contactor [Q10] off Key relay [K20] off Fuse [F60] "+48 VDC ESO Circuit" OK
Resulting conditions	Login possible. Login method controlled by parameter 503.

Functions and parameters

Operation and connection sequences



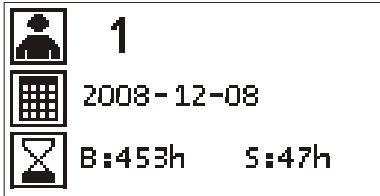

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Event:	2a. Login via unit connected to the MCU
Previous event	1. Battery is connected
Action(s)	The operator uses the key or other unit connected to the MCU. Input A5-X131:19 is activated.
Contributing factors	<p>Parameter 503 = '1' or '2'</p> <p>"Central Information Display (CID)" displays a key symbol when the truck is in logged-out mode:</p> <div> </div>
Resulting conditions	<p>Login approved: "Central Information Display (CID)" displays a status image for approximately 2 seconds:</p> <div> </div> <p>Main contactor [Q10] on Key relay [K20] on Login rejected: "Central Information Display (CID)" displays:</p> <div> </div> <p>Main contactor [Q10] off Key relay [K20] off</p>

Functions and parameters

Operation and connection sequences

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Event:	2b. Login via keypad
Previous event	1. Battery is connected
Action(s)	The operator enters a four-figure or five-figure PIN code, depending on the parameter setting, + Enter "green button"
Contributing factors	<p>Parameter 503 = '3' or '4' "Central Information Display (CID)" displays:</p>  <p>Parameter 503 = '5' or '6' "Central Information Display (CID)" displays:</p> 
Resulting conditions	<p>Login approved: "Central Information Display (CID)" displays a status image for approximately 2 seconds:</p>  <p>Main contactor [Q10] on Key relay [K20] on Login rejected: "Central Information Display (CID)" displays:</p>  <p>Main contactor [Q10] off Key relay [K20] off</p>

Functions and parameters

Operation and connection sequences

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Event:	2c. Login via "ID key" option
Previous event	1. Battery is connected
Action(s)	The operator presses the green button and then, within 5 seconds, passes the ID key over the scanner.
Contributing factors	<p>Parameter 503 = '7' or '8'</p> <p>"Central Information Display (CID)" displays a key symbol when the truck is in logged-out mode:</p> <div> </div> <p>Once the green button has been pressed, it is possible during a 5 second period to log in with the ID key. The following is displayed:</p> <div> </div>
Resulting conditions	<p>Login approved:</p> <p>"Central Information Display (CID)" displays a status image for approximately 2 seconds:</p> <div> </div> <p>Main contactor [Q10] on Key relay [K20] on</p> <p>Login rejected:</p> <p>"Central Information Display (CID)" displays:</p> <div> </div> <p>Main contactor [Q10] off Key relay [K20] off</p>

Functions and parameters

Operation and connection sequences

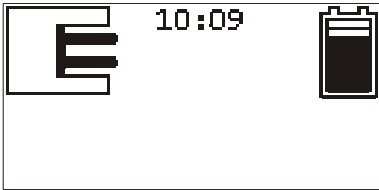
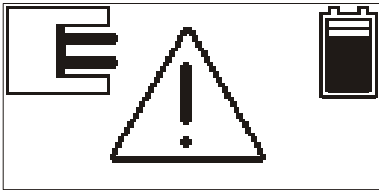
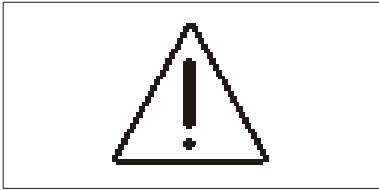
Publication No.	Date	Valid from serial number	T-code
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Event:	2d. Login to emergency driving mode
Previous event	1. Battery is connected
Action(s)	<p>From the login screen, 'i' is pressed, so that the CID displays the "Information screen". On the information screen, select:</p> <div></div> <p>and then press the green button</p>
Contributing factors	–
Resulting conditions	<p>"Central Information Display (CID)" displays a status image for approximately 2 seconds:</p> <div></div> <p>Main contactor [Q10] on Key relay [K20] on</p>

Functions and parameters

Operation and connection sequences

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Event:	3. Basic control criteria
Previous event	<p>2a. Login via unit connected to the MCU or 2b. Login via keypad or 2c. Login via "Access card" option or 2d. Login to emergency driving mode 2a, 2b & 2c – CID displays the standard screen:</p>  <p>2d – CID displays the standard screen for emergency driving:</p>  <p>2d – During emergency driving and if a LID is installed and activated, this displays the following:</p>  <p>At the same time, all LED icons on the CID & LID flash and a buzzer sounds.</p>
Action(s)	<p>Weight is put on the operator seat so that the sensor [B49] closes and activates input A5-X130:41 "INP. SEAT SWITCH" The safety pedal [B31] is depressed and activates input A5-X130:31 "INP. LEFT FOOT SWITCH"</p>
Contributing factors	The emergency stop button [S21] is not depressed.
Resulting conditions	It is possible to drive the truck, 2a, 2b & 2c, according to the parameters for the current operator profile and emergency driving, 2d, with greatly reduced speed for all functions.

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Operation and connection sequences

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Event:	4. Driving in fork direction
Previous event	3. Basic control criteria
Action(s)	The travel direction selector [B36] is moved towards the forks and input A1-X505:4 increases from approximately 2.6 V to approximately 4.7 V. The accelerator [B32] is depressed and this has an effect on input A5-X130:17.
Contributing factors	Operator parameter 3: Maximum speed in fork direction. Operator parameter 4: Acceleration. Emergency login.
Resulting conditions	CID indication for driving and fork direction comes on. Output A5-X131:20 is increased to approximately +48 V and the mechanical brake [Q1] is released. In terms of the support arm brake: The PWM outputs A5-X131:39 and A5-X131:12. are modulated so that the brakes [Q16] and [Q17] are released. The drive motor is supplied with three-phase voltage from the transistor regulator [T1].

Event:	5. Driving in drive wheel direction
Previous event	3. Basic control criteria.
Action(s)	The travel direction selector [B36] is moved towards the drive wheel and input A1-X505:4 decreases from approximately 2.6 V to approximately 0.6 V. The accelerator [B32] is depressed and this has an effect on input A5-X130:17.
Contributing factors	Operator parameter 2: Maximum speed in drive wheel direction. Operator parameter 4: Acceleration. Emergency login.
Resulting conditions	CID indication for driving and drive wheel direction comes on. Output A5-X131:20 is increased to approximately +48 V and the mechanical brake [Q1] is released. In terms of the support arm brake: The PWM outputs A5-X131:39 and A5-X131:12. are modulated so that the brakes [Q16] and [Q17] are released. The drive motor is supplied with three-phase voltage from the transistor regulator [T1].

Event:	6. Braking in neutral
Previous event	4. Driving in fork direction or 5. Driving in drive wheel direction.
Action(s)	The accelerator [B32] is released and this has an effect on input A5-X130:17.
Contributing factors	Operator parameter 5: Automatic braking.
Resulting conditions	The frequency of the drive motor three-phase voltage is reduced.

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Event:	7. Reverse braking
Previous event	4. Driving in fork direction or 5. Driving in drive wheel direction or 6. Braking in neutral
Action(s)	The travel direction selector [B36] is moved to the position opposite to the travel direction and input A1-X505:4 is changed from approximately 2.6 V to approximately 0.6 V or to approximately 4.7 V.
Contributing factors	Operator parameter 5: Automatic braking. Service parameter 201: Reversing
Resulting conditions	The frequency of the drive motor three-phase voltage is reduced to change the phase sequence when the motor is idling, and then increases to a frequency in line with the amount the accelerator is depressed.

Event:	8. Depressing the brake pedal
Previous event	4. Driving in fork direction or 5. Driving in drive wheel direction or 6. Braking in neutral
Action(s)	The brake pedal [B32] is depressed and this affects inputs A5-X130:4 & A5-X130:18 in that the voltage is increased at one of them and reduced to a comparable degree at the other.
Contributing factors	Operator parameter 5: Automatic braking. Depressing the brake pedal.
Resulting conditions	The frequency of the drive motor three-phase voltage is reduced. When the brake pedal is depressed beyond 90 % of its possible travel: The voltage at output A5-X131:20 is reduced and the mechanical brake [Q1] is activated. When stationary: When the pedal is depressed for more than 5 % of its possible travel, the voltage at output A5-X131:20 is reduced, and the mechanical brake [Q1] is activated. In terms of the support arm brake: When the pedal is depressed 50 - 90 % of its possible travel, PWM outputs A5-X131:39 and A5-X131:12. are modulated so that the brakes [Q16] and [Q17] are released.

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Operation and connection sequences

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Event:	9. Steering
Previous event	3. Basic control criteria
Action(s)	The steering wheel is rotated taking effect on the following inputs: – A1-X504:13 “STEER SENSOR 1 PULSE A” – A1-X504:4 “STEER SENSOR 1 PULSE B” – A1-X504:11 “STEER SENSOR 2 PULSE A” – A1-X504:2 “STEER SENSOR 2 PULSE B”
Contributing factors	–
Resulting conditions	A telegram is sent via the CAN bus to the steering servo electronics. The steering servo motor rotates the drive unit so that its new position corresponds to the position of the steering wheel.

Event:	10. Reach carriage operation: Out
Previous event	3. Basic control criteria.
Action(s)	The control for the reach carriage [B21] is moved away from the operator, and input A1-X505:11 increases from approximately 2.6 V to approximately 4.7 V at the end position of the control.
Contributing factors	–
Resulting conditions	The pump motor is supplied with three-phase voltage from the transistor regulator [T2]. Output A5:OUT.(PWM) REACH OUT lowers the voltage Current flows through the proportional valve [Q7] The proportional valve [Q7] is opened in proportion to the current that flows through.

Event:	11. Reach carriage operation: In
Previous event	3. Basic control criteria.
Action(s)	The control for the reach carriage [B21] is moved towards the operator and input A1-X505:11 is reduced from approximately 2.6 V to approximately 0.6 V at the end position of the control.
Contributing factors	–
Resulting conditions	The pump motor is supplied with three-phase voltage from the transistor regulator [T2]. Output A5:OUT.(PWM) REACH IN lowers the voltage Current flows through the proportional valve [Q6] The proportional valve [Q6] is opened in proportion to the current that flows through.

Functions and parameters

Operation and connection sequences

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Event:	12. Fork lift
Previous event	3. Basic control criteria.
Action(s)	The control for the fork lift [B20] is moved towards the operator and input A1-X505:2 is reduced from approximately 2.6 V to approximately 0.6 V at the end position of the control.
Contributing factors	Service parameter 1261: Transition flows during raising.
Resulting conditions	<p>The pump motor is supplied with three-phase voltage from the transistor regulator [T2].</p> <p>Free lift:</p> <p>Output T2-K1:10 "OUT.(PWM) INITIAL MAST LIFT" reduces the voltage.</p> <p>Output A5-131:26 "OUT(PWM) MAIN MAST LIFT" retains the full voltage.</p> <p>Current flows through the proportional valve [Q3].</p> <p>The proportional valve [Q3] is opened in proportion to the current that flows through.</p> <p>Proportional valve [Q2] closed.</p> <p>Transition between free lift and main lift:</p> <p>Output T2-K1:10 "OUT.(PWM) INITIAL MAST LIFT" successively increases the voltage at the same time as output A5-131:26 "OUT(PWM) MAIN MAST LIFT" successively reduces the voltage.</p> <p>Proportional valve [Q3] begins to close at the same time as proportional valve [Q2] begins to open.</p> <p>Main lift:</p> <p>Output A5-131:26 "OUT(PWM) MAIN MAST LIFT" reduces the voltage.</p> <p>Output T2-K1:10 "OUT.(PWM) INITIAL MAST LIFT" retains the full voltage.</p> <p>The proportional valve [Q2] is opened in proportion to the current that flows through.</p> <p>Proportional valve [Q3] closed.</p>

Functions and parameters

Operation and connection sequences

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Event:	13. Fork lowering
Previous event	3. Basic control criteria.
Action(s)	The control for fork lift [B20] is moved away from the operator and input A1-X505:2 increases from approximately 2.6 V to approximately 4.7 V at the end position of the control.
Contributing factors	Service parameter 1262: Transition flows during lowering.
Resulting conditions	<p>Main lift: Output A5-131:40 "OUT(PWM) MAIN MAST LOWER" reduces the voltage Output T2-K1:2 "OUT.(PWM) INITIAL MAST LOWER" retains the full voltage The proportional valve [Q4] is opened in proportion to the current that flows through Proportional valve [Q5] closed Transition between main lift and free lift: Output A5-131:40 "OUT(PWM) MAIN MAST LOWER" successively increases the voltage at the same time as output T2-K1:2 "OUT.(PWM) INITIAL MAST LOWER" successively reduces the voltage. Proportional valve [Q4] begins to close at the same time as proportional valve [Q5] begins to open. Initial lift: Output T2-K1:2 "OUT.(PWM) INITIAL MAST LOWER" reduces the voltage. Output A5-131:40 "OUT(PWM) MAIN MAST LOWER" retains the full voltage. The proportional valve [Q5] is opened in proportion to the current that flows through. Proportional valve [Q4] closed.</p>

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Event:	14. Fork tilt, backwards/upwards
Previous event	3. Basic control criteria.
Action(s)	The control for the fork lift [B22] is moved towards the operator and input A1-X505:17 is reduced from approximately 2.6 V to approximately 0.6 V at the end position of the control.
Contributing factors	–
Resulting conditions	The pump motor is supplied with three-phase voltage from the transistor regulator [T2]. Output A5-X131:37 "OUT.AUX DIRECTION A" reduces the voltage. Output A5-X131:11 "OUT.AUX DIRECTION B" remains high. Current flows through the coil [Q8]. The tilt cylinder is pressurised via the non-return valve. On sideshift, or some other optional function: the following also applies: Output A5-X131:38 "OUT.TILT/SIDESHIFT/AUX 1" remains high. No current flows through the coil [Q18].

Event:	15. Fork tilt, backwards
Previous event	3. Basic control criteria.
Action(s)	The control for fork lift [B22] is moved away from the operator, and input A1-X505:17 increases from approximately 2.6 V to approximately 4.7 V at the end position of the control.
Contributing factors	–
Resulting conditions	Output A5-X131:37 "OUT.AUX DIRECTION A" remains high. Output A5-X131:11 "OUT.AUX DIRECTION B" reduces the voltage. Current flows through the coil [Q9]. The tilt cylinder is drained to the tank. On sideshift, or some other optional function: the following also applies: Output A5-X131:38 "OUT.TILT/SIDESHIFT/AUX 1" remains high. No current flows through the coil [Q18].

Functions and parameters

Operation and connection sequences

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Event:	16. Sideshift, right
Previous event	3. Basic control criteria.
Action(s)	The control for the fork lift [B23] is moved towards the operator, and input A1-X505:3 is reduced from approximately 2.6 V to approximately 0.6 V at the end position of the control.
Contributing factors	Sideshift as an optional function.
Resulting conditions	The pump motor is supplied with three-phase voltage from the transistor regulator [T2]. Output A5-X131:37 "OUT.AUX DIRECTION A" remains high. Output A5-X131:11 "OUT.AUX DIRECTION B" reduces the voltage. Current flows through the coil [Q9]. Output A5-X131:38 "OUT.TILT/SIDESHIFT/AUX 1" reduces the voltage. Current flows through the coil [Q18]. The piston rod end of the sideshift cylinder is drained to the tank.

Event:	17. Sideshift, left
Previous event	3. Basic control criteria.
Action(s)	The control for fork lift [B23] is moved away from the operator, and input A1-X505:3 increases from approximately 2.6 V to approximately 4.7 V at the end position of the control.
Contributing factors	Sideshift as an optional function.
Resulting conditions	The pump motor is supplied with three-phase voltage from the transistor regulator [T2]. Output A5-X131:37 "OUT.AUX DIRECTION A" remains high. Output A5-X131:11 "OUT.AUX DIRECTION B" reduces the voltage. Current flows through the coil [Q8]. Output A5-X131:38 "OUT.TILT/SIDESHIFT/AUX 1" reduces the voltage. Current flows through the coil [Q18]. The piston rod end of the sideshift cylinder is pressurised.

Functions and parameters

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Event:	18. Ergo cabin, tilt up
Previous event	12. Fork lift
Action(s)	–
Contributing factors	Factory parameter 1104: Permitted cabin tilting. Factory parameter 1259: Calibration, Ergo cabin up
Resulting conditions	Output T2-K1:10 “OUT.(PWM) CABIN TILT UP” reduces the voltage. The proportional valve [Q11] opens in proportion to the voltage applied to it. The cabin tilt cylinder is pressurised.

Event:	18. Ergo cabin, tilt down
Previous event	13. Fork lowering
Action(s)	–
Contributing factors	Service parameter 355: Offset, cabin tilting down Factory parameter 1104: Permitted cabin tilting. Factory parameter 1260: Calibration, Ergo cabin down.
Resulting conditions	Output T2-K1:2 “OUT.(PWM) CABIN TILT DOWN” reduces the voltage. The proportional valve [Q21] opens in proportion to the voltage applied to it. The cabin tilt cylinder is drained to the tank.

Event:	19. Logout
Previous event	2. Login.
Action(s)	The operator presses the red button.
Contributing factors	–
Resulting conditions	The login screen is displayed and login is possible. The screen to be displayed is determined by service parameter 503.

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4.8 Functions

4.8.1 General overview

Key

[] = reference to electrical component in the wiring diagram.

{high} = refers to a voltage level of around 48 V.

{low} = refers to a voltage level of around 0 V.

Components

ACT = Traction transistor regulator [T1] (AC Traction)

ACH = Lift transistor regulator [T2] (AC Hydraulic)

CAN = Communication network (Controller Area Network)

CID = Central display [A1] (Central Information Display)

EPS = Steering servo [A2] (Electronic Power Steering)

ESD = Static discharge (Electrostatic Discharge)

GFU = Universal unit (General Function Unit) [A8]

LID = Upper display [P6] (Load Information Display) (option)

MCU = Main processor [A5] (Main Control Unit)

All these components intercommunicate via two CAN buses with the MCU connected to each. The CID and LID use the first CAN bus and the EPS, ACT and ACH use the second.

In its closed position, the main contactor [Q10] supplies the power stage of the truck, e.g. ACT and ACH.

In its closed position, the key contactor [K20] supplies other electronic units

Functions and parameters

Functions

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4.8.2 MCU – Main Control Unit

General

The MCU is the main processor in the truck and communicates with the traction transistor regulator, the lift transistor regulator, the steering servo and the displays via two CAN networks. The truck parameter and error code settings are also stored in the MCU. A back-up copy of the parameters is also saved in the CID.

The MCU monitors and regulates the truck functions relating to steering, driving, braking, hydraulics, communication and various other things.

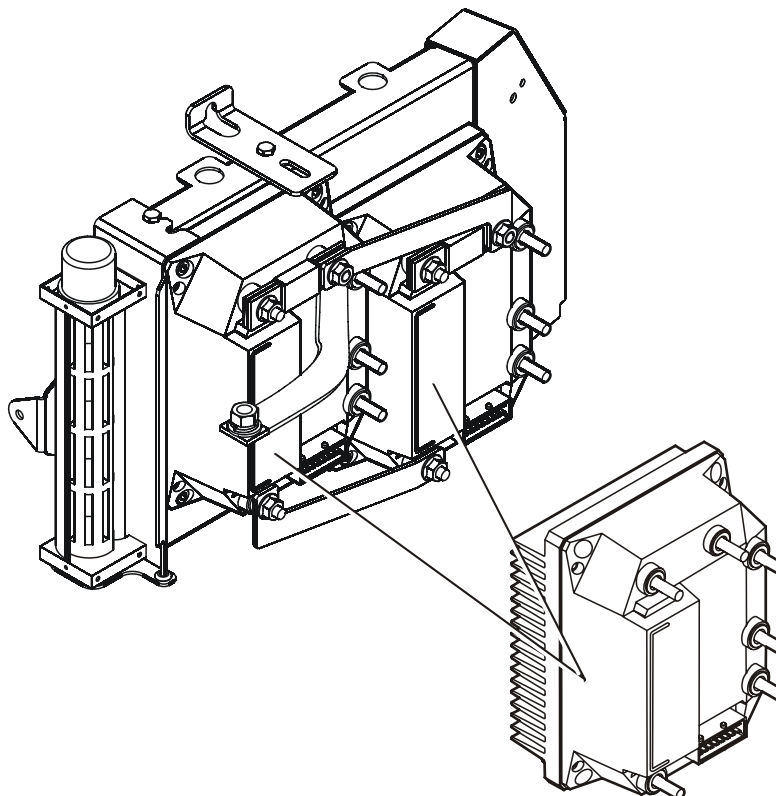
The TruckCom service program must be used for downloading new software.

System communication

The MCU is connected to both CAN1 and CAN2 and acts as a hub for CAN communication between the various processors in the truck.

CAN1 is used for communication between the MCU and the various displays (CID and LID). CAN2 is used for communication between the MCU, the steering servo (EPS), and the transistor regulators (ACT and ACH).

4.8.3 ACT/ACH transistor regulators



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General

The transistor regulators have a green LED to indicate OK status. On start-up, the LED flashes twice and then stays on.

The basic software for controlling the drive motor, pump motor and various hydraulic valves, is stored in the transistor regulators.

The transistor regulators have dedicated internal monitoring of CAN communication, DC voltage levels, their own temperature and motor temperature.

Any malfunctions are registered by the transistor regulators, and the information is sent via CAN to the MCU, which registers the error code and displays it on the CID. Once an error is detected, it is also signaled by the LED going out or starting to flash.

The transistor regulators are replaceable and can be reprogrammed using TruckCom via CAN.

4.8.4 Start-up

The truck checks the system by testing the inputs, outputs, voltage and communication, etc.

4.8.5 Shutdown

Shutdown is initiated by pressing the red "Logout" button. Subsequently, the main contactor must open before the key contactor.

The check that the main contactor opens is made by activating the ACT transistor regulator, when stationary, to load the battery circuit. If the contactor is open, the voltage is slightly reduced and the condition for shutting down the electronics and opening the key contactor is met.

Functions and parameters

Functions

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4.8.6 Driving

Introduction

To be able to drive the truck, the operator seat must be loaded, the safety pedal depressed, a direction of travel selected, and the accelerator depressed.

If the operator seat is not loaded and the safety pedal is depressed, a disable indication will be displayed in the CID.

If no direction has been selected, the two green arrows that indicate direction alternate.

If the accelerator is depressed before the safety pedal or the seat is depressed, the accelerator must be released before then being depressed again.

Acceleration and speed reduction

When the accelerator is depressed, the MCU will determine the highest applicable speed and increase the speed by using the ACT to regulate the frequency of the drive motor three-phase voltage.

The maximum speed is parameter-based.

Pressing hard on the accelerator results in sudden acceleration, and pressing lightly results in more restrained acceleration.

The acceleration is parameter-based.

Once the accelerator is released the motor brake will be activated and the speed will be reduced. The more the pedal is released, the greater the retardation.

The retardation is parameter-based.

Monitoring

Acceleration is reduced when battery voltage is low, as well as in emergency driving mode.

Retardation is reduced in emergency driving mode.

Speed is monitored so that actual speed is reduced when retardation is requested.

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Reversing

If the travel direction selector is pressed in the opposite direction to the one that was selected, the truck will use the motor brake to come to a standstill before then changing direction of travel.

Brake

The brake pedal function has three different positions:

- If the pedal is depressed to a maximum of 50 % of its possible travel, the truck is braked by the motor.
- If the pedal is depressed between 50 and 90 % of its possible travel, the support arm brakes, which are not part of the standard equipment, will be used, along with the motor brake.
- If the pedal is depressed by more than 90 % of its possible travel, the mechanical brake is activated, along with the two other brakes.

If the truck is equipped with support arm brakes, a pressure sensor that measures the load on the forks determines the degree of brake force to be used.

When the truck is at a standstill, the parking brake will be activated once the brake pedal is depressed by more than 5 %.

Monitoring

The brake pedal has two channels to the MCU. These are reciprocally inverted. Both channels are monitored and must be within 0.25 – 4.75 V.

The parking brake, or the mechanical brake, only has two positions - completely on or completely off.

The support arm brakes are controlled by the MCU and monitored for short circuits and circuit breaks.

If an error is detected on the support arm brakes, the travel speed is reduced to the speed that applies for a truck without support arm brakes.

Functions and parameters

Functions

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Travel speed

The travel speed in both drive wheel and fork direction can be adjusted separately using parameters.

If it is not equipped with support arm brakes, the truck can drive at 10 km/h in the drive wheel direction and at 7 km/h in the fork direction.

If the truck has support arm brakes installed, it may drive at 14 km/h in the drive wheel direction. In the fork direction, 10 km/h is permitted if the truck is unladen and 8 km/h with a load of more than 1000 kg on the forks.

If the parking brake is released and the travel direction selector is held in a specific direction, the truck will drive at around 1 km/h. The speed can be adjusted by means of a parameter.

Other speeds are also possible depending on the limitations, warnings and errors that are specified.

There are three digital inputs that can generate special speeds; these are parameter-based, provided as special options.

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4.8.7 Steering

Steering position check

The truck has position steering that is speed-controlled. The pulse generator in the steering wheel sends a steering speed to the CID, and this is sent as a CAN telegram to the MCU. Then the MCU converts this value into a variance reading from the current position and sends a new setpoint to the EPS, which controls the steering motor.

Monitoring

The pulse generator is a twin generator and two separate pulse trains are received by the CID. If the two signals do not reach the same level within a given time limit, an error code is output.

There is also monitoring to ensure that the pulse generator speed is not abnormally high.

Steering speed

At low travel speeds, the steering speed is high so that large wheel manoeuvres can be carried out using only small movements of the steering wheel. At higher travel speeds, the steering speed is reduced to prevent loss of sensitivity in the truck steering.

The steering speed can be adjusted with an operator parameter.

Monitoring

In the case of a high steering value the current steering speed must be higher than a given speed, otherwise an error code is output.

In the case of a low steering value, the speed must be under a given speed, otherwise an error code is output.

When the steering servo is deactivated, the actual steering speed must be 0, otherwise an error code is output.

Functions and parameters

Functions

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Steering reference

The steering sensor is used as a 180 degree reference for the 360 degree steering.

The MCU calculates the position and stores it in the memory. The steering sensor emits an active signal as a result of a half turn of the wheel; the value is changed at 90 and 270 degrees.

Monitoring

At start-up the last known steering angle is used by the program. If the steering angle has been changed during the time the truck has been switched off, the saved steering angle is unreliable. Another steering angle measurement then starts and restricts steering movement to 180 degrees until the sensor signal and steering angle have been updated.

The reference sensor is located at the steering angles ± 90 degrees, resulting in 180 degrees between each signal.

Once a steering angle has been updated for the first time after start-up, the wheel position is checked each time the reference sensor is passed. If the sensor signals are not received within a specified tolerance or are completely absent, an error code is output.

Travel speed limitation

During start-up, travel is disabled until the steering servo is initialised and ready.

No speed limitation is made on the basis of steering turning angle size.

Compass card

In the truck symbol on the CID, a compass card with 8 arrows is displayed. This indicates the direction the truck is moving in. If the operator has not selected the direction of travel, or if there is a steering reference error, the arrow goes out.



The compass card indicates that the truck will be moving in the direction of the drive wheel.

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4.8.8 Hydraulic system

This section describes the standard functions of the hydraulic system.

Definitions

The various ranges for fork movement are free lift, transition and main lift.

Free lift is the range where only the free lift cylinder is working.

Transition is the range where both the free lift and main lift cylinders work. When the forks are raised through the transition range, lifting is increasingly taken over by the main lift cylinders, with simultaneous slowing of the free lift cylinder, as the forks approach the upper limit of the transition range.

The main lift is the range beyond the free lift range where only the main lift cylinders work.

Note that free lift, transition and main lift denote the ranges, and not the extent to which the forks move up or down.

Controls

All control values are sent from the CID to the MCU via CAN.

The control that operates the function must be registered as unaffected after start-up and before the function is used.

Lift

The mast and the forks' position in the mast are detected.

The main positions are free lift, transition up towards main lift, main lift and transition down towards free lift.

Free lift and main lift use separate valves. For this reason, they can be used simultaneously in the transition range.

Monitoring:

- Lift speed is reduced when battery capacity is low.
- The lift control is checked to ensure it is within 0.3 – 4.7 V.
- The electrical circuits of the lift and lowering valves are monitored for short circuits and breaks in the cabling.

Functions and parameters

Functions

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Reach movement

To detect reach carriage position, the reach movement uses a scale with two corresponding sensors, [B26] and [B27]. Once the reach carriage starts to approach its end position, the speed is reduced, and it is stopped by means of a controlled movement.

Monitoring:

- The reach movement control is checked to ensure it is within 0.3 – 4.7 V.
- The electrical circuits of the reach valves are monitored for short circuits and breaks in the cabling.
- The two digital signals of the reference sensors are monitored by checking that the reach carriage has moved after 1 second when an outward movement is requested.

Lift height limitation

The seven service parameters 380 – 386 may be used to set height limitations, and parameters 387 – 393 are used for activation and to specify whether the various limitations must apply.

When it comes to level selection, the limitations that have been set by parameter will have higher priority than the height selection, and the movement is stopped once the forks approach the limit. Continuation of the lift is disabled. When this happens, a disable symbol is displayed in the CID.

Lift height limitations that are not parameterized as "Obligatory" may be overridden with a cancel button. Pressing the button removes the limitation for 5 seconds. Within this period the forks are permitted to pass the next limit. Once the forks have passed the limit, they are permitted to stay at that height until they are lowered back under the limit.

Maximum height limitation

The maximum lift height is set by a factory parameter. Once the forks reach this level, the movement is stopped and lift continuation is prevented. The cancel button for lift height limitation cannot be used to override this limit.

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Auxiliary/Extra functions (option)

All the hydraulic functions in this section, as listed below, are connected to the hydraulic main valve's extra outputs: AUX (auxiliary).

The functions cannot be used at the same time as certain other hydraulic functions.

All extra functions can be calibrated by means of a number of parameters.

Fork tilt

Fork tilt uses the first auxiliary output.

If an angle sensor is connected, a LED icon comes on in the LID (option) when the forks are in their initial position, in other words, when the angle is zero degrees.

Sideshift

Sideshift uses the second auxiliary output.

If a sensor is connected to measure the mid position, a LED icon in the LID (option) comes on once the mid position is reached.

Forkspread and telescopic forks

The telescopic forks use the third auxiliary output and forkspread uses the fourth auxiliary output.

Functions and parameters

Height preselector, description of function

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4.9 Height preselector, description of function

4.9.1 Using the height preselector





To be able to use the height preselector functions, the factory parameter for the height preselector (HPS, Height PreSelection) must be set.

If the parameter has been set, height preselector mode is activated once the truck is started.

Height preselector mode can be activated and deactivated by depressing and holding down the preselector button on the CID for 3 seconds.

4.9.2 Symbols

Height preselector mode is indicated in the CID by the following symbols:

Symbol	Description	Symbol	Description
	Height preselector active		Pick up
	Delete height		Deposit

4.9.3 Buzzer

The CID buzzer is used to warn of an error, for instance if a level that has been entered is not programmed, or if the entered level does not exist.

The buzzer is also used to inform the operator when a target has been achieved.

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4.9.4 Height preselector levels

The height preselector levels are organised in aisles with levels – heights – defined for each aisle. A maximum of 200 heights can be stored and service parameter 511, *Aisle configuration*, gives the number of heights/aisle.

The applicable parameter values are listed below:

Value	Aisles	Heights/aisle
1	1	200
2	2	100
3	4	50
4	5	40
5	8	25
6	10	20
7	20	10
8	40	5

In the CID and LID displays, the aisles and levels are written in the format "aa:nnn", where "aa" is the aisle and "nnn" is the level for the row.

Depending on the setting of the parameter for the number of aisles, there can be one or two digits for the aisle and one to three digits for the level.

4.9.5 Level selection

The height preselector levels are selected using the CID keypad.

To select a level, press the digits on the keypad, leaving no more than 0.5 of a second between each one that you press. Once the final digit has been entered, the level selected will appear approximately 0.5 of a second later.

When a aisle is to be selected, the digits are entered in the same way as for a level, but the sequence is ended by pressing the green button (I).

Levels can be selected irrespective of the aisle. If a new aisle is selected, any previous levels selected are reset

Event	Display
Press the number 1	--:--
Press the number 4 (within 0.5 s)	--:--
Press the green button (I) (within 0.5 s)	14:--
Press the number 9	14:--
Wait 0.5 s until level 9 is selected	14:9

Functions and parameters

Height preselector, description of function

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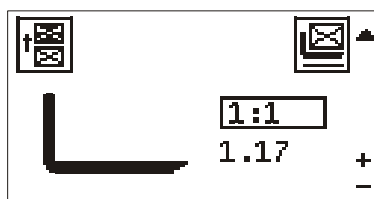
4.9.6 Height programming

IMPORTANT:

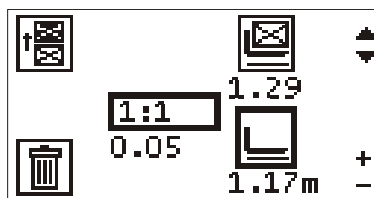
Height programming requires that parameter 510 allow free access or that the CAN key/TruckCom is connected.

There is storage space for 200 different pick up and deposit levels.

Once the user screen is displayed, press buttons 1 – 9 to remove the height preselector screen:



From this screen, pressing the i-button makes the teach-in screen for the heightpreselector appear:



The CID screen displays a box containing the selected aisle and level. The forks' present level is given under the box.

On the right are the pallet symbols for pick up and deposit, with the programmed heights shown underneath.

Plus/minus or numerical buttons are used to specify the level. When the green button is pressed, the current height is stored for the selected level.

The current height is saved as a pick up height, and the deposit height is saved automatically as the difference for the current height as determined by service parameter 378 for the Pick up/Deposit difference.

The new heights will be displayed under the pick up and deposit symbols.

The deposit height can be programmed individually using the arrow buttons. Using the arrow buttons, you can select the icon for deposit height. Then you press the green button.

The deposit height must be within the minimum and maximum values specified by service parameter 378. If the height is outside this interval, it will not be saved and the buzzer emits a warning sound.

To leave the programming screen, press the C-button.

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4.9.7 Height preselector and TruckCom

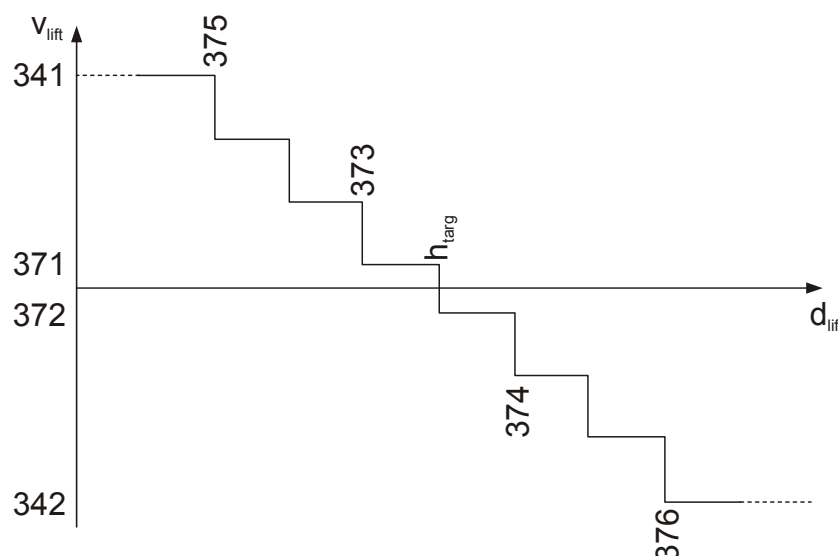
The height preselector can also be managed via TruckCom. This makes it possible to enter the saved heights on a PC or PDA.

In this way, you can archive them in a file and update a truck using the settings from the file.

4.9.8 Lift/lowering movement

When the sequences are performed, the lift movements are checked by the service parameters 341, 342, 371 – 377 to get them to interrupt the movement at the right height, and as gently and precisely as possible.

The transfer near the target height is limited by a curve that is defined by a number of parameters:



341: Max. lift speed, 342: Max lowering speed, v_{lift} : Lift speed, h_{targ} : Target height, d_{lift} : Lift movement length

Once the forks are nearer to the target height than the specification of parameters 375/376, *Braking Distance Lift/Lower*, the movement slows in three stages to the height set by parameters 373/374, *Creep Distance Lift/Lower*.

Once the forks are nearer to the target height than the creep distance, the forks move at the speed defined by parameters 371/372, *Creep Speed Lift/Lower*.

Once the forks reach the target height, the movement is stopped.

If the measured stop height differs from the target height by more than the maximum error, defined by parameter 377, *Max. StopHeight Error*, a warning code is displayed at the same time as the CID emits a warning sound.

Functions and parameters

Hydraulic system 6000

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4.10 Hydraulic system 6000

4.10.1 General

The hydraulics on the truck consist of a pump that takes oil by suction from the tank and pumps it to the main valve located in the reach carriage.

The main valve distributes the oil to the reach cylinder and the mast.

The return oil from the reach cylinder and mast is pumped via the main valve through the filter to the tank.

4.10.2 Tank

The tank has a capacity of approximately 25 litres. It is manufactured from electrically conductive plastic.

Topping up of the hydraulic oil is via the return filter.

The hydraulic oil from the hydraulic system and the breathing air are filtered by the return filter. There is no filter between the tank and the pump.

A separate plug for oil level checking is located on the tank.

4.10.3 Filter

Return filter

The hydraulic oil from the hydraulic system and the tank breathing air are filtered by the return filter.

Filtering is very important for the service life of the hydraulic oil and hydraulic system. Filtering of the hydraulic oil is by means of a filter element with a filter rating of 10 micrometres. Once the filter element is saturated with particles, a bypass valve opens and the hydraulic oil goes straight to the tank, bypassing the filter element without being filtered. The air filter and filter element can be replaced.

Dehumidification filter

For applications where there is air humidity, the intake air has to be dehumidified before reaching the tank. If this does not happen there is a risk of the air condensing and water mixing with the hydraulic oil.

In the cold store version, the dehumidification filter is used in combination with a special return filter with a specially adapted breather filter connection for connecting to the dehumidification filter.

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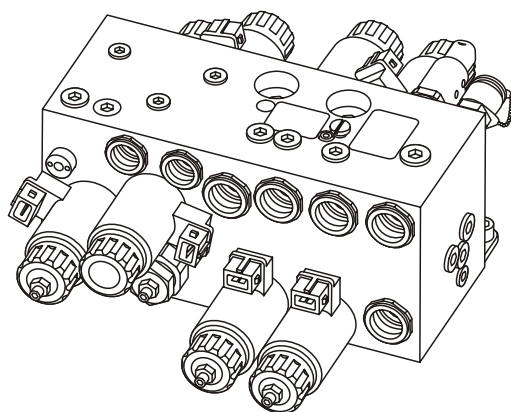
4.10.4 Hydraulic pump

The pump is of gear wheel type (inner gear wheel) with fixed displacement and is driven directly by the electric motor. The metallic contact surfaces in the pump require very good lubrication, placing strict requirements on the grade of hydraulic oil. They also require that the motor rpm does not drop below a specified minimum value.

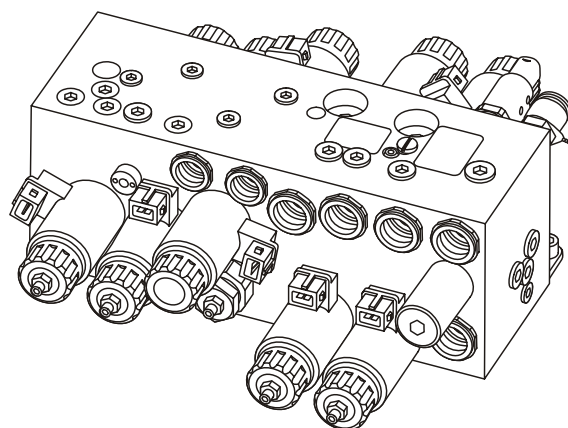
4.10.5 Valve block

Main valve block

The main valve block is located on the reach carriage. There are two different versions of the main valve block: one for RRE and one for RRE Ergo.



RRE main valve



RRE Ergo main valve

The valves for main lift, free lift, reach movement and cabin tilt are pressure-compensated proportional valves. By means of pressure compensation, the flow through the valve is kept constant for a given valve deflection, irrespective of the load on the forks/cylinder.

The valve slides of the main valve block's proportional valves are individually adjusted and cannot be replaced.

Pressure limitation

To protect the system against overpressure there is a pressure limiter DV1 in the main valve block. The pressure limiter opens once the system pressure exceeds 25 MPa (250 bar).

Thanks to the main cylinders' and free lift cylinder's proportional areas, no adjustment of the pressure limiter is needed to set the maximum load. The valve block comes supplied with the pressure limiter DV1 set at 25 MPa (250 bar).

For the reach movement and (where applicable) cabin tilt, there are also pressure reducing valves DV2 and DV3, set at 15 MPa (150 bar).

Functions and parameters

Hydraulic system 6000

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Calibration and adjustment of lowering and lift valves

The lowering valves for main lift Q4 and free lift Q5, and the lift valves for main lift Q2 and free lift Q3 need calibrating to operate to their optimum.

For the lowering valves Q4 and Q5, the opening point must be calibrated, using CID in servicemode, see "Free lowering and main lowering valve calibration" on page 13 – 14. The opening point determines the lowest lowering speed.

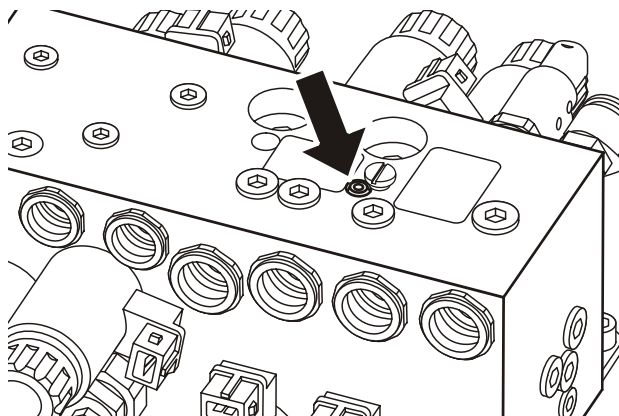
For the lowering valves Q4 and Q5, also the maximum opening point that determines the maximum lowering speed, must be mechanically adjusted, see "14.2.3 Adjustment of maximum opening point" on page 14 – 10.

For the lift valves Q2 and Q3, the opening point must be calibrated. For the lift valves the opening point is very important for maintaining optimum transition from free lift to main lift.

Emergency lowering valve

On the top of the valve block is an emergency lowering valve (arrow) for the mast. Both the main lift cylinders and the free lift cylinder are connected to the emergency lowering valve.

The emergency lowering valve is opened by loosening a 3 mm allen screw in the valve block. The screw only needs opening 1½ turns to activate emergency lowering.



IMPORTANT!

The screw must only be tightened to 2.5 Nm on closing.

Other valve blocks

Located in the fork carriage is a valve block in one of two versions - for fork tilt and sideshift, or for fork tilt and extra functions.

Apart from these valve blocks there is the option of an additional one or two extra hydraulic functions using an extra valve block in one of two versions - for one or two hose reels.

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4.10.6 Cylinders

Main lift cylinder

The main lift cylinders are single-action cylinders without pistons. The diameter of the rod determines the pressure area and the rod is controlled in the cylinder tube by a control belt. Hydraulic oil surrounds the whole rod up to the top sleeve. Sealing against leaks is in the top sleeve.

Free lift cylinder

The free lift cylinder is a single-action sealed piston cylinder.

Cylinders for the reach movement, cabin tilt, side-shift and fork tilt

For the reach movement, cabin tilt, sideshift and fork tilt, double-action cylinders with piston seal are used.

Functions and parameters

Hydraulic system 6000

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4.10.7 Lift and lowering function

Lifting and lowering of free lift

The free lift is controlled by a proportional valve, Q3/Q5, of replaceable cartridge design.

On free lift lifting, the pump is started and the proportional valve Q3 is fully opened. The lifting speed is regulated by the pump speed.

Free lift is lowered using the proportional valve Q5.

Transition from free lift to main lift

The valve block has separate connections and proportional valves for main lift (Q2) and free lift (Q3). This allows a smooth transition from free lift to main lift, by reducing valve opening for Q3 at the same time as increasing valve opening for Q2.

In a similar fashion, the proportional valves Q4 and Q5 give smooth transition on lowering, by reducing valve opening for Q4 at the same time as increasing valve opening for Q5.

Lifting and lowering of main lift

Main lift is controlled by a proportional valve, Q2/Q4, of replaceable cartridge design.

On main lift lifting, the pump is started and the proportional valve Q2 is fully opened. The lifting speed is regulated by the pump speed.

Main lift is lowered using the proportional valve Q4.

Reach movement, in and out

The valve for control of the reach movement, Q6/Q7, is a proportional slide valve, non-replaceable.

For reach movement in the IN direction, the pump is started and valve Q6 is activated. For reach movement in the OUT direction, the pump is started and valve Q7 is activated. The speed of the reach movement is regulated by the pump speed, with valves Q6 and Q7 providing soft start and stop for the function.

The pressure limiter DV2 opens if the pressure exceeds 15 MPa (150 bar) on reach movement in the OUT direction. On reach movement in the IN direction, the pressure is limited by DV1 to 25 MPa (250 bar).

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Simultaneous operation of mast lift and reach movement

Under normal circumstances the flow for mast lift and the reach movement are regulated by pump speed.

To allow simultaneous operation of these functions, the flow must instead be limited using the proportional valves Q2/Q3 and Q6/Q7.

This reduces the maximum speed of mast lift and reach movement when simultaneously operated.

4.10.8 Extra functions

Extra functions are activated by valve Q8/Q9, non-replaceable, in the main valve block.

If Q8 is activated, pump pressure P is connected to connection A1, and connection B1 is connected to T (tank return).

If Q9 is activated, pump pressure P is connected to connection B1, and connection A1 is connected to T (tank return). Pump speed regulates the speed, and current limitation of the electric motor determines the pressure level for the extra function.

4.10.9 Cabin tilt (RRE Ergo)

Cabin tilt is controlled by a proportional slide valve, Q11/Q21, non-replaceable.

To lift the cabin (tilt it up), the pump is started and Q11 is activated, and to lower the cabin, Q21 is activated.

Hydraulic priority system

The priority system means cabin tilt takes priority over mast lift.

If both functions are activated, cabin tilt will not be affected, whereas the flow for mast lift is limited.

The normal position of the priority system valve directs the pump flow to the proportional valve for cabin tilt Q11/Q21.

If Q11/Q21 is open, the flow travels to the cabin tilt cylinder, and if Q11/Q21 is not open, the pressure increases and causes the priority system valve to move, so that the flow travels to mast lift Q2/Q3.

If Q2/Q3 is open, the flow travels to the main lift cylinders or the free lift cylinder, respectively; if Q2/Q3 is not open, the pressure increases and affects the pressure reducing valve, DV1, which opens the path to the tank.

Functions and parameters

Hydraulic system 6000

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Cabin tilt (RRE Ergo) during servicing

During servicing, the cabin must always be tilted so that its centre of gravity passes the centre of rotation; the cabin will then drop gently into its end position, which is the service position.



Warning!

Risk for personnel injuries, crushing.

The hydraulics does not stop the tilt motion beyond the balancing point.

Make sure that the area that will house a tilted cab is free from personnel and objects prior to the commencement of tilt motion.

To raise the the cabin up out of the service position, the pump is started and Q21 is activated.

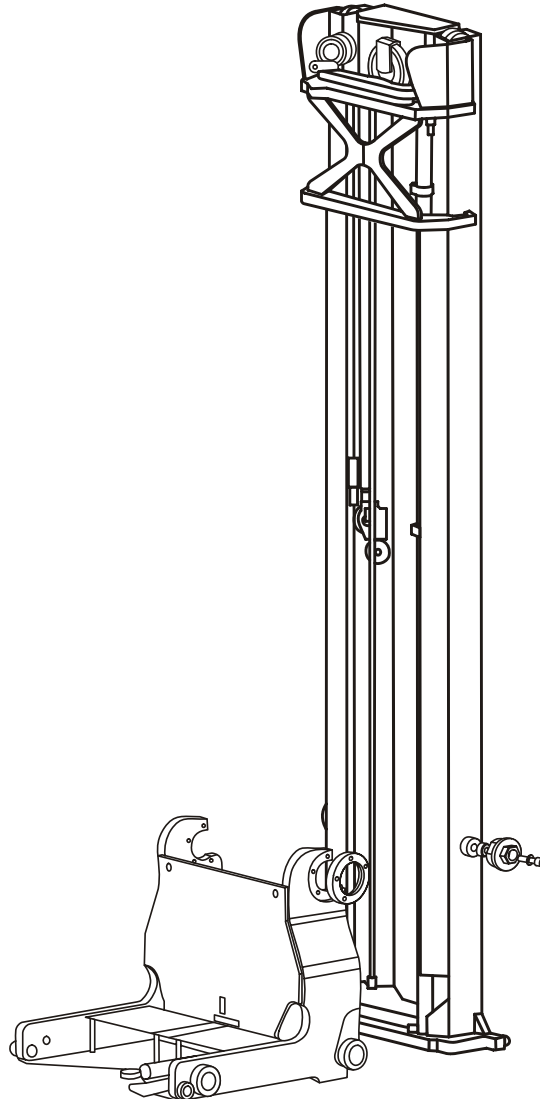
Cabin tilt in the event of hydraulic or electrical power loss

If required, the cabin can be tilted up with a traverse, without the valve being activated. However, in such a case Q21 must be activated, once the cabin is to be tilted back. On the magnetic tube to Q21 there is an allen screw, the emergency lowering screw, which allows opening of Q21 in the event of the electronics being out of action.

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4.11 Mast 7000

4.11.1 Mast and reach carriage



The mast and reach carriage are available in a number of different sizes and these can be combined in a specific way. The reach carriages and masts that are suitable for the truck are determined by factors such as the width between the support arms, load capacity and the lift height of the mast.

When ordering a replacement mast, TMHE Technical Support should be contacted to identify the right mast for the truck in question.

Functions and parameters

Lifting devices

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4.12 Lifting devices

4.12.1 Fork extensions

The standard fork can be extended, allowing you to transport bulkier items. When the fork extension is fitted, a check is made that it is suitable for fitting to a standard truck fork (see the details on the identification plate). Only use in pairs when the specified fork dimensions match, and the length of the truck fork is greater than or equal to the minimum permitted truck fork length.

IMPORTANT!

Please note that load capacity is reduced once the fork extensions are attached.

IMPORTANT!

The fork extension must not be used if the mounting is unsafe or if it is damaged, dirty or icy. The chamfered underside must face downwards. Daily visual inspection is recommended.

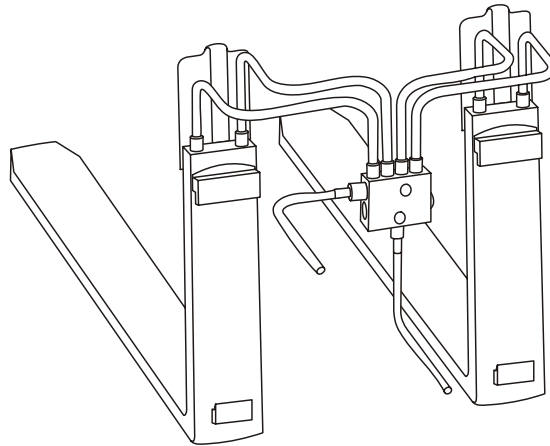
4.12.2 Telescopic forks

KOOI forks, manufactured by the Meijer Special Equipment Company in the Netherlands are a specially designed fork with a thickness of 56 mm. This flatter fork can be used for load carriers with lower tunnel heights. The telescopic forks are fitted in the same way as normal forks and can be moved in their holders in the same way. All forks have an identification plate on their upper surface. The plates provide important information on the fork's technical data, e.g. the maximum load capacity of the fork.

The telescopic forks are operated using a closed, self-lubricating oil circuit. These forks come supplied with oil that meets an ISO 4406 cleanliness standard code of 17/12.

The telescopic forks must be tested every year in line with ISO 5057 requirements (see the Maintenance section). The international standard must be applied when checking the forks, with the exception of those sections that refer to "fork blades and shafts", as the inner fork must not be subjected to wear.

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The identification plates of the telescopic forks have had an L and an R added to them. The forks are fitted on the left and right fork holder, respectively, as viewed from the operator seat. The forks are pushed up on the fork holder so that the locking catch fits in the holder recess.

Along the rear of the fork holder there is a distribution valve.

The maximum fluid pressure for the telescopic forks is 20 MPa (200 bar).

Functions and parameters

Parameters

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4.13 Parameters

4.13.1 General

The trucks control system can store a number of different parameters. These are used to configure the truck according to the task to be performed. The parameters are split into two groups:

- Operator parameters – The operator parameters (range 1 – 100) are used to adapt the trucks response to a specific operator or task. Up to ten operator parameters can be stored.
- Service parameters – The service parameters (range 101 – 1000) are used to adapt the trucks performance/response; they cover all other parameters not covered by the operator parameters.
- Factory parameters – (range 1001 – 1250). Truck-specific parameters.
- Calibration parameters – (range 1251 – 1500) are used to calibrate valves, weight indication, etc.

Operator parameters are displayed and changed only for a selected operator, but if a CAN service key is connected, the parameters for all operators can be displayed and changed. Operator parameters can be changed by the operator if the truck's program is set up for this.

The service parameters can be changed once a suitable CAN service key or PDA/PC has been connected to the truck.

Factory parameters can ONLY be changed once a specially configured PDA/PC has been connected to the truck.

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4.13.2 Displaying/changing parameters

See the "Settings menu (SET)" for instructions on how to display and change the parameter settings.

4.13.3 Parameters

Operator parameters, overview

No.	Min.	Max.	Increments	Default	Unit	Description
1	1	6	1	3		Steering, speed-dependent deflection
2	1	10	1	10	10 %	Maximum speed, drive wheel direction
3	1	10	1	8	10 %	Maximum speed, fork direction
4	3	10	1	8	10 %	Acceleration
5	3	10	1	8	10 %	Automatic brake
6	500	10 000	100	1000	mm	Height above free lift once the Ergo cabin starts tilting.

Operator	Parameter number
1	1–10
2	11–20
3	21–30
4	31–40
5	41–50
6	51–60
7	61–70
8	71–80
9	81–90
10	91–100

Functions and parameters

Parameters

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Service parameters, overview

No.	Min.	Max.	In-cre-ment	De-fault	Unit	Description
General parameters						
101	0	5000	100	0	h	Service interval. Time till next service in B-time. 0 = deactivated
104	0	120	1	20	min	Log-off timer 0 = 4 hours
107	1	20	1	12		Battery size
108	0	20	5	5	%	Limit for start of reduction in performance as % of BDI
109	0	2	1	0		Delete data on login 0 = Do not clear data 1 = Clear histogram log 2 = Clear crash log
110	0	100	1	0		Impact sensor X 0 = deactivated 1–100 sensitivity setting
111	0	100	1	0		Impact sensor Y 0 = deactivated 1–100 sensitivity setting
112	0	1	1	0		Impact sensor, action after collision 0 = Login with special PIN code to reset sensor 1 = Restart the truck to reset
113	50	1000	1	246		Shunt resistance for BDI (resistance for the shunt resistance in question)
114	0	7	1	0		Travel alarm 1 (X) setting
115	0	3	1	0		Travel alarm 2 (Y) setting
116	0	1	1	0		Door open action (cold store cabin) 0 = Disable operation 1 = Speed limited to 2.5 km/h
Driving parameters						
201	50	100	10	100	%	Reversing speed
202	30	100	10	100	%	Creep speed
203	30	100	10	100	%	Half speed
204	30	100	10	100	%	Safety speed
205	0	100	10	100	%	Speed limitation 1
206	0	100	10	100	%	Speed limitation 2
207	0	100	10	100	%	Speed limitation 3

Functions and parameters

Parameters

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No.	Min.	Max.	In-cre-ment	De-fault	Unit	Description
208	0	1	1	1		Creep speed activated
209	0	15000	1	100	mm	Height limit for speed reduction
210	0	140	5	140	0.1 km/h	Speed limitation above selected height (see 209)
211	0	840	1	10	mm	Reach length for speed reduction
212	0	140	5	140	0.1 km/h	Speed limitation after selected reach length (see 211)
Hydraulic parameters						
301	0	31	1	0		Extra (Aux.) function valve 1
302	0	31	1	1		Extra (Aux.) function valve 2
303	0	31	1	2		Extra (Aux.) function valve 3
304	0	31	1	8		Extra (Aux.) function valve 4
305	10	100	1	100		Extra (Aux) max. current strength, direction A1
306	10	100	1	100		Extra (Aux) max. current strength, direction A2
307	10	100	1	100		Extra (Aux) max. current strength, direction A3
308	10	100	1	100		Extra (Aux) max. current strength, direction A4
309	10	100	1	100		Extra (Aux) max. current strength, direction B1
310	10	100	1	100		Extra (Aux) max. current strength, direction B2
311	10	100	1	100		Extra (Aux) max. current strength, direction B3
312	10	100	1	100		Extra (Aux) current strength, direction B4
313	0	50	1	25		Extra (Aux.) draining 1
314	0	50	1	25		Extra (Aux.) draining 2
315	0	50	1	25		Extra (Aux.) draining 3
316	0	50	1	25		Extra (Aux.) draining 4
317	12	300	1	57		Extra (Aux) max. flow, direction A1
318	12	300	1	104		Extra (Aux) max. flow, direction A2
319	12	300	1	100		Extra (Aux) max. flow, direction A3
320	12	300	1	12		Extra (Aux) max. flow, direction A4
321	12	300	1	47		Extra (Aux) max. flow, direction B1
322	12	300	1	83		Extra (Aux) max. flow, direction B2

Functions and parameters

Parameters

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No.	Min.	Max.	In-cre-ment	De-fault	Unit	Description
323	12	300	1	47		Extra (Aux) max. flow, direction B3
324	12	300	1	12		Extra (Aux) max. flow, direction B4
325	101	9999	1	505		Extra (Aux.) overlapping time, direction A1
326	101	9999	1	505		Extra (Aux.) overlapping time, direction A2
327	101	9999	1	505		Extra (Aux.) overlapping time, direction A3
328	101	9999	1	505		Extra (Aux.) overlapping time, direction A4
329	101	9999	1	505		Extra (Aux.) overlapping time, direction B1
330	101	9999	1	505		Extra (Aux.) overlapping time, direction B2
331	101	9999	1	505		Extra (Aux.) overlapping time, direction B3
332	101	9999	1	505		Extra (Aux.) overlapping time, direction B4
341	30	100	10	100	%	Lift speed
342	30	100	10	100	%	Lowering speed
343	30	100	10	100	%	Reach speed
344	0	1	1	1		Fork speed reduction enable
345	0	20000	10	0	mm	Special height 1
346	0	20000	10	0	mm	Special height 2
347	0	140	5	140	0.1 km/h	Raise/lower function not possible above this speed
355	500	10000	100	500	mm	Starting point for Ergo cabin to tilt down
371	0	100	1	5	%	Height preselector, creep speed lift before stop
372	0	100	1	5	%	Height preselector, creep speed lowering before stop
373	0	100	1	25	mm	Height preselector, creep distance lift
374	0	100	1	25	mm	Height preselector, creep distance lowering
375	0	1000	10	350	mm	Height preselector, braking distance lift
376	0	1000	10	350	mm	Height preselector, braking distance lowering
377	0	100	1	10	mm	Height preselector, max. variation in stop height
378	40	250	1	120	mm	Height preselector, p+d height, difference
379	0	500	5	200	kg	Height preselector, automatic load detection limit
380	10	15000	10	10	mm	Lift height limitation 1
381	10	15000	10	10	mm	Lift height limitation 2
382	10	15000	10	10	mm	Lift height limitation 3

Functions and parameters

Parameters

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No.	Min.	Max.	In-cre-ment	De-fault	Unit	Description
383	10	15000	10	10	mm	Lift height limitation 4
384	10	15000	10	10	mm	Lift height limitation 5
385	10	15000	10	10	mm	Lift height limitation 6
386	10	15000	10	10	mm	Lift height limitation 7
387	0	2	1	0		Lift height limitation 1, function selection 0 = deactivated 1 = Can be overridden 2 = Cannot be overridden
388	0	2	1	0		Height limitation 2, function selection, see 387
389	0	2	1	0		Height limitation 3, function selection, see 387
390	0	2	1	0		Height limitation 4, function selection, see 387
391	0	2	1	0		Height limitation 5, function selection, see 387
392	0	2	1	0		Height limitation 6, function selection, see 387
393	0	2	1	0		Height limitation 7, function selection, see 387
394	0	2	1	0		Height limitation 8, function selection, see 387
395	0	15000	10	0	mm	Height limitation 1 controlled by external signal 0 = deactivates the limit
396	0	15000	10	0	mm	Height limitation 2 controlled by external signal 0 = deactivates the limit
397	0	15000	10	0	mm	Height limitation 3 controlled by external signal 0 = deactivates the limit
CID1 parameters						
501	0	0	1	0		Display illumination
503	0	8	1	3		Operator access 1, 2 = Key/button (controlled from the MCU) 3, 4 = Keypad using 100 PIN codes 5, 6 = Keypad using DHU 7, 8 = ID unit Odd number = Access to operator parameter Even number = No access to operator parameter

Functions and parameters

Parameters

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No.	Min.	Max.	In-cre-ment	De-fault	Unit	Description
504	0	255	1	255		ID card setting, department low
505	0	255	1	255		ID card setting, department high
506	0	255	1	255		ID card setting, truck type low
507	0	255	1	255		ID card setting, truck type high
508	0	1	1	0		Load information
509	0	15	1	15		Summer activation 0 = Disabled 1 = Write to parameter sound 2 = Safety pedal and option buttons 3 = 1 + 2 4 = Press button 5 = 1 + 4 6 = 2 + 4 7 = 1 + 2 + 4
510	0	1	1	0		Height preselector available
511	1	8	1	7		Height preselector, number of rows
512	0	0	1	0		Truck type RRE = 0
513	0	1	1	0		Date format 0 = yyyy-mm-dd 1 = dd-mm-yyyy

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Factory parameters, overview

No.	Min.	Max.	Increment	Default	Unit	Description
General parameters						
1001	0	5	1	0		Truck type 0 = Unknown truck type 1 = RRE140 2 = RRE160 3 = RRE180 4 = RRE200 5 = RRE250
1002	0	1	1	0		Drive motor 0 = Small 1 = Large
1003	0	1	1	0		Pedal type 0 = Standard pedals 1 = Direction switch on pedals
1004	0	1	1	0		Steering servo 0 = Small 1 = Large
1005	0	1	1	0		Pump motor 0 = Small 1 = Large
1006	0	1	1	0		Hydraulic pump 0 = Small 1 = Large
1007	0	4	1	0		Steering lever configuration 0 = Lift, reach 1 = Lift, reach, Aux1 2 = Lift, reach, Aux1, Aux2 3 = Lift, reach, Aux1, Aux2, Aux3 4 = Lift, reach, Aux1, Aux2, Aux3, Aux4 (fifth lever with button depressed)
1008	0	2	1	0		Type of mast 0 = 1.6 t 1 = 2.0 t 2 = 2.5 t
1009	0	1	1	0		Type of height measurement 0 = Base (only digital sensors) 1 = Full (with rotating encoder)
1010	0	20000	2	6000	mm	Max lift height
1016	0	1	1	0		Type of weight measurement 0 = Base version. Only in the free lift range.

Functions and parameters

Parameters

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No.	Min.	Max.	Increment	Default	Unit	Description
Option, activate (on/off) parameters, 0 = Deactivated 1 = Activated						
1101	0	1	1	0		Support arm brakes
1102	0	1	1	0		Reverse steering
1103	0	1	1	0		HPS, height preselector
1104	0	1	1	0		Cabin tilt activated (Ergo)
1105	0	1	1	0		Cold store cabin
1106	0	1	1	0		LID
1107	0	1	1	0		Height limitation
1108	0	1	1	0		Travel alarm available
1109	0	1	1	0		Travel direction indicators (flashers) available

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Calibration parameters, overview

No.	Min.	Max.	Increment	Default	Unit	Description
Hydraulic parameters						
1252	-200	200	5	0	mA	Free lift calibration
1253	-200	200	5	0	mA	Free lowering calibration
1254	-200	200	5	0	mA	Lift calibration for main mast
1255	-200	200	5	0	mA	Lowering calibration for main mast
1256	-200	200	5	0	mA	Calibration of reach out
1257	-200	200	5	0	mA	Calibration of reach in
1258	0	30	1	10	%	Extra flow for reach mast valve. Extra flow in % used for reach mast valve. In this way the reach mast function is controlled by the pump and not limited by the valve.
1259	-200	200	5	0	mA	Ergo cabin, tilt up calibration
1260	-200	200	5	0	mA	Ergo cabin, tilt down calibration
1261	15	40	1	30	%	Flow on upward transition. Specifies the flow in % when the free lift valve should close during lift transition from free lift to main lift. For smooth transition between the two mast sections.
1262	15	40	1	30	%	Flow during downward transition. Specifies the flow in % when the main lowering valve should close during lowering transition from main lift to free lift. For smooth transition between the two mast sections.
1263	0	1000	10	240	kg	Weight of the fork carriage in kg, for calculation of the load on the forks.
1264	0	2000	10	990	kg	Weight of the mast + fork carriage in kg, for calculation of the load on the forks.
1265	120	840	12	564	mm	Reach length. The total length of the reach movement (in mm) so that the movement can be dampened in the end positions.
1266	-300	300	5	0	kg	Weight 1 calibration
1267	500	3000	5	1000	kg	Reference weight 2
1268	-300	300	5	0	kg	Weight 2 calibration
1269	-200	200	5	0	mA	Calibration of free lift lowering speed.
1270	-200	200	5	0	mA	Calibration of main lift lowering speed.
1271	0	9000	2	800	mm	Free lift, height reference
1272	0	100	2	30	mm	Main lift, height reference
1273	0	6000	2	3000	mm	Free lift height

Functions and parameters

Parameters

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5 – Installation

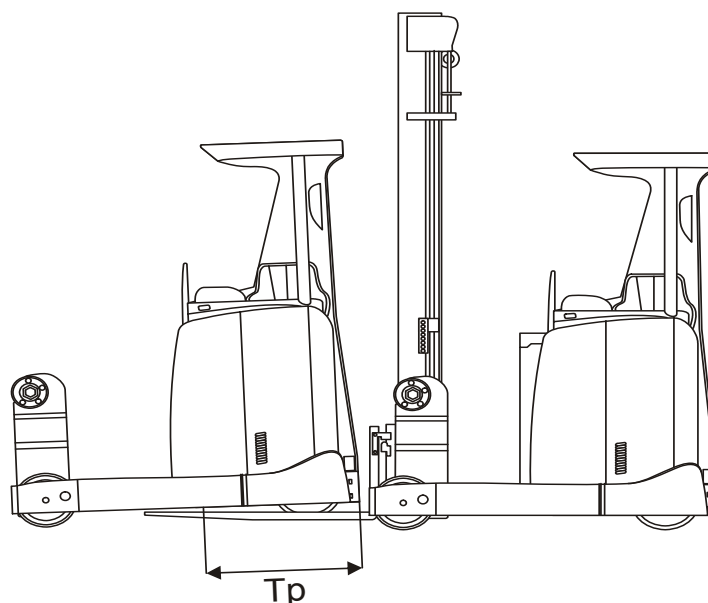
5.1 Transporting the truck

There are two ways to transport the truck when the battery is not installed.

Method 1

When the truck is to be transported over long distances you should use a fork lift truck with the following minimum lift capacity:

Load	RRE 140– RRE 160	RRE 180– RRE 200	RRE 250
Load centre distance (Tp)	800	900	900
Weight without battery and mast	1600	2000	2100



Insert the forks under the support arms and lift as illustrated.

Method 2

To move the truck over short distances, you can use an extension cable from an adjacent battery.

5.2 Initial operation



DANGER!

Risk of centre of gravity shifting.

Due to the weight of the mast, the battery must be in position in the truck before the mast is fitted.

5.2.1 Placing the battery

Check that the battery is of the correct weight as shown on the truck's identification plate. The weight of the battery affects the truck's stability and braking capacity.



DANGER!

Risk of centre of gravity shifting.

Battery weight that is too low results in a deterioration in stability and braking capacity.

The battery weight must conform to the details specified on the truck identification plate.

1. Supply the truck with power from an external source.
2. Activate the parking brake.
3. Retract the mast to its innermost position.
4. Pull the handle at the bottom on the right in front of the operator seat to release the battery lock.
5. Extend the reach carriage.
6. Switch off the truck.
7. Lift the new battery in.
8. Lock the battery.
9. Connect the battery cut out connector to the battery.
10. Start the truck.
11. Retract the reach carriage to its innermost position. Make sure the battery catch engages in the battery lock. A sharp metallic sound will be heard confirming locking has occurred.



DANGER!

Risk of battery falling.

If the truck tips the battery may fall out if the battery catch is not locked.

Check that the battery catch is locked.



DANGER!

Risk of battery falling.

When replacing a battery, there is a danger of it slipping and falling. Always use an approved lifting device to lift the battery and use a battery yoke that suits the battery.

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5.2.2 Parameters on initial operation

Full calibration of the functions is described in section “13.3 Parameter settings”.

Battery

The size (capacity) of the battery fitted in the truck must be specified using parameter 107

Parameter no.	RRE140		RRE160			RRE180		RRE200			RRE250	
	450	600	450	450	750	600	600	750	600	750	450	600
107												

So as not to run the battery down completely, a limit is set beyond which a reduction in truck performance must be initiated

Battery capacity limit for reduction in truck performance	Parameter no. 108
Limit as a % of BDI	5

Load indicator

The load indicator must be calibrated for each truck. Incorrect load calibration can result in incorrect speed and brake force limits and the load indicator on the CID/LID giving the wrong indication.

Weight indicator, type	Parameter no. 1016
Base version, measurement only on free lift	0
Full measurement	1

Can be combined with the LID (Load Indication Display) (option) and then height information is displayed on the LID.

Ergo cabin

When the cabin is not in its very lowest position, there is a reduction in speed (4 km/h), acceleration (30 %) and automatic braking (30 %) to give gentler driving.

Ergo function	Parameter no.	
	6	355
Height above free lift once the Ergo cabin starts tilting	1000	
Height when the Ergo cabin starts to tilt down		500

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Cold store cabin

When the cabin door is not shut, the truck is braked by the motor until it stops.

An option is available that allows the truck to be driven (2.5 km/h) with the door open; this may be deselected.

Door open action (cold store cabin)	Parameter no. 116
Disable operation (driving)	0
Speed limited to 2.5 km/h	1

5.2.3 Parameters for optional equipment

Height measurement (option)

Parameter 1009 sets the type of height measurement the truck is to have.

Can be combined with the LID (Load Indication Display) (option) and then height information is displayed on the LID.

Height measurement, type	Parameter no.	
	344	1009
Base version, only position sensors	–	0
Full measurement (option)	1	1

Travel speed limitation, height-dependent

Requires the full height measurement option. Limits travel speed when the forks are above a given predetermined height.

Speed reduction for a selectable height	Parameter no.	
	209	210
Height limit for speed reduction	mm	–
Speed limitation above selected height	–	km/h

Travel speed limitation, reach movement dependent

Limits travel speed when the mast is extended beyond a given predetermined millimetre limit.

Speed reduction for a selectable reach movement length	Parameter no.	
	211	212
Reach movement length for speed limitation	mm	–
Speed limitation beyond a selected limit	–	km/h

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Travel speed limitation, parameter-dependent

Configured and activated using a service parameter.

Select speed (parameter 205–207) and height limitation (parameter 395–397). Can be combined or used separately.

	Input signal 1 Parameter no.		Input signal 2 Parameter no.		Input signal 3 Parameter no.	
	205	395	206	396	207	397
Deactivated	100	0	100	0	100	0
Activated	1-99	1-1500	1-99	1-1500	1-99	1-1500

Collision sensor (BT)

The values in parameters 110 and 111 must be adapted to match the truck application.

Collision sensor, functional operation	Parameter no.		
	110	111	112
Deactivated	0	0	–
Activated, restart of truck without collision PIN code not possible	1–99	1–99	0
Activated, restart of truck without collision PIN code possible	1–99	1–99	1

5.2.4 Mast, fitting

See section "15.1.5 Placing the mast on the truck".

Installation

Initial operation

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6 – Maintenance

6.1 Introduction, maintenance

To maintain a high level of truck safety, and to minimise downtimes, all the points specified in the service program should be carried out.

The intervals specified are those meeting the truck manufacturer's requirements for a truck – RRE160/180/200/250 – in standard application at approximately 1000 operating hours/year. The local operating environment may require service intervals that differ from those specified.

Once a truck's service interval has been determined, the hour meter is used in the first instance to determine when servicing is to be carried out.

To maintain truck safety, only spare parts approved by the manufacturer may be used for servicing and repairs.

During the truck warranty period: If repairs or servicing have been carried out by non-authorised personnel, or if non-approved spare parts are used, the truck warranty ceases to be valid.

IMPORTANT:

At each service, checks must be made that the truck functions as usual and is safe. These checks are to be performed in accordance with the instructions for daily care that are in the operator's manual.

Maintenance

Periodic maintenance

T-code
815, 816

Valid from serial number
6051502

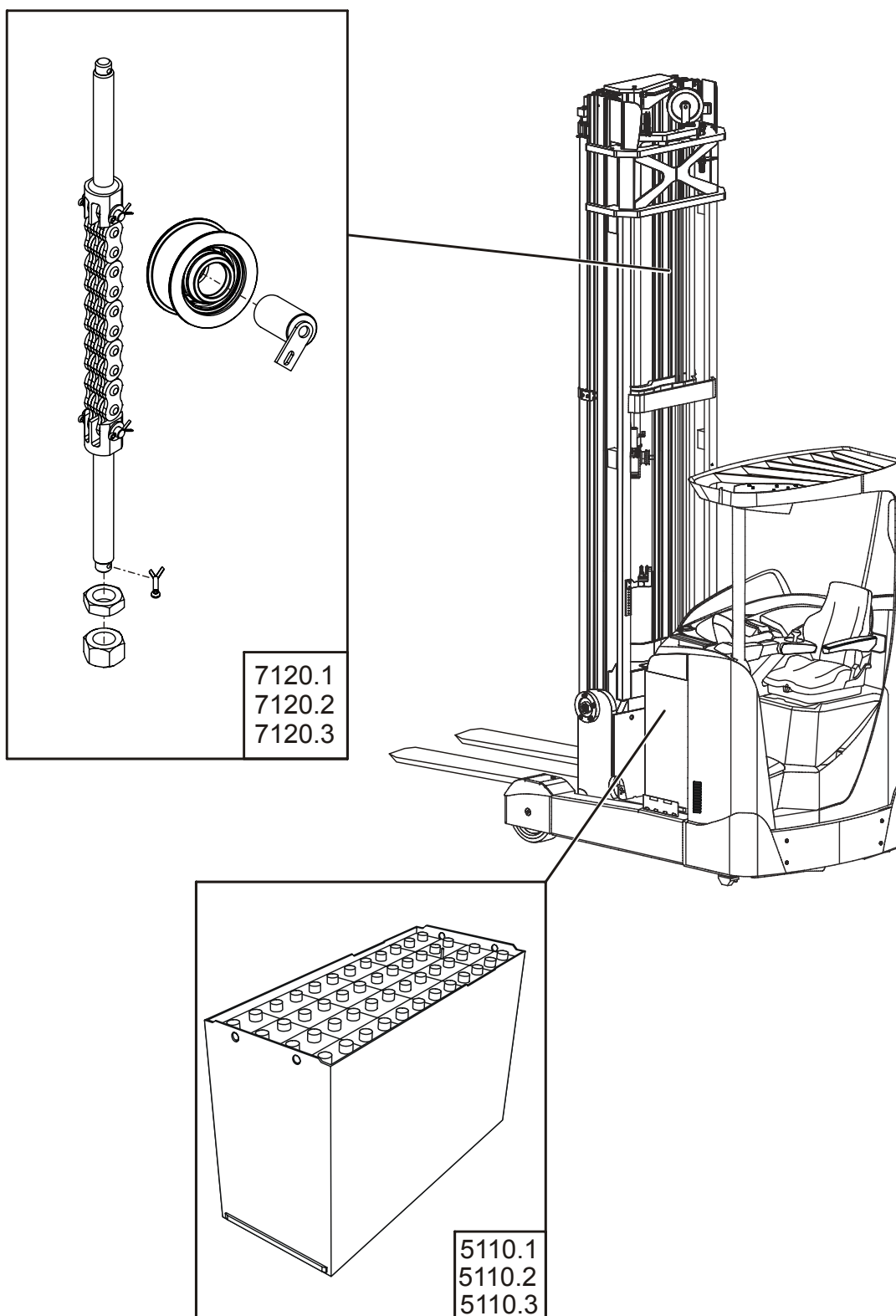
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6.2 Periodic maintenance

6.2.1 Every 500 B-hours/180 days

Estimated duration: 39.5 min.



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Position	Component	Type of work	Work to be carried out	See Section
5110.1	Battery	Inspection	Open all the battery's cell plugs and check the electrolyte level. This should be 10-15 mm above the top edge of the cell plates. Top up as needed.	
5110.2	Battery	Inspection	Check that the connections of the power cables to the battery, truck and charger are not damaged or overheating.	
5110.3	Battery	Inspection	Visual inspection to ensure that the battery cell and terminal protectors are undamaged	
7120.1	Mast	Inspection	Visual inspection of wear on lifting chains, chain bolts, chain mountings and chain wheels	
7120.2	Mast	Inspection	Adjustment of lifting chains, check the tightening torque of the lock nuts and inspect the cotter pins	
7120.3	Mast	Lubrication	Lifting chains	

Maintenance

Periodic maintenance

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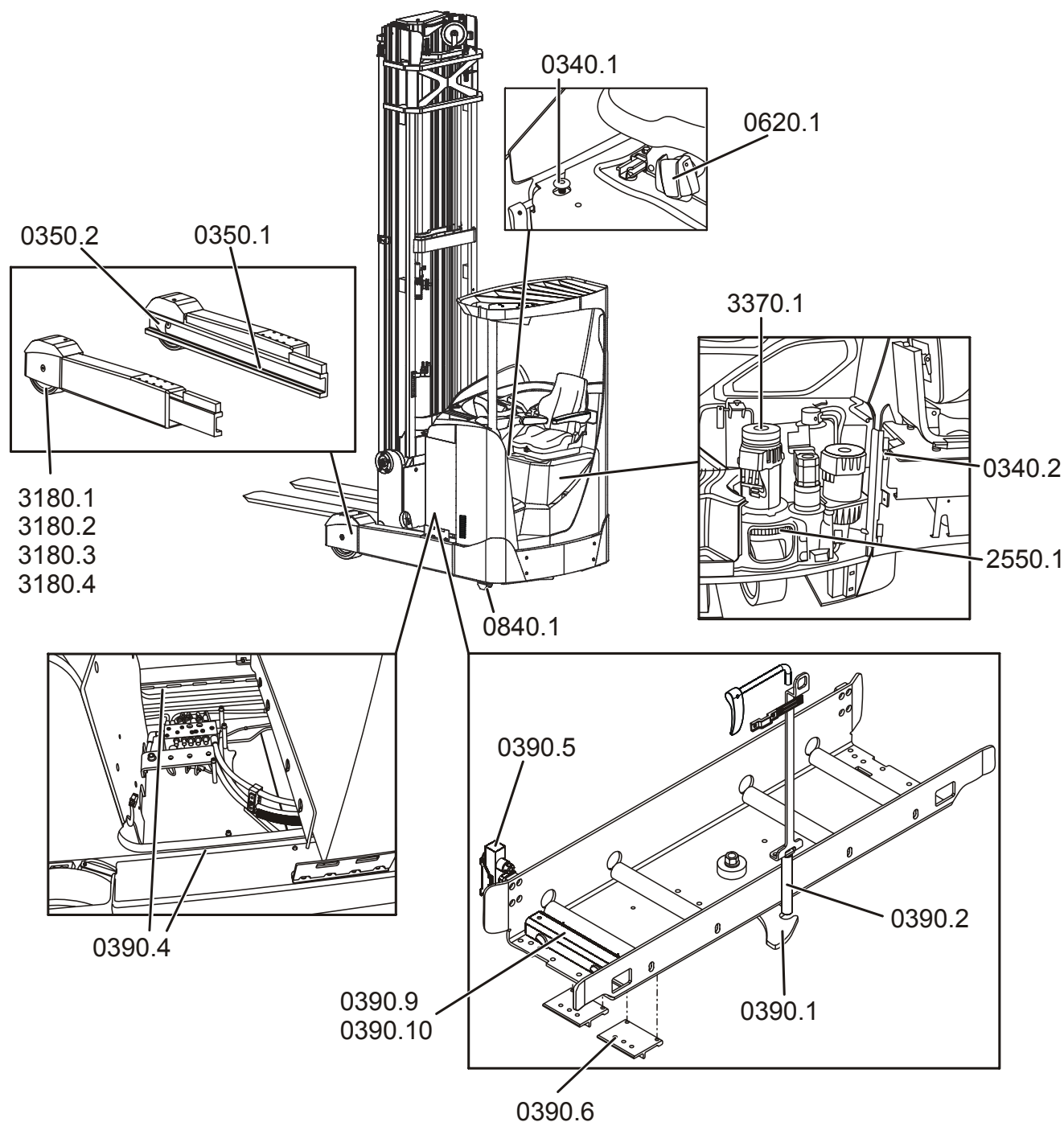
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6.2.2 Every 1000 B-hours/360 days

Estimated duration: 124.3 min.

<TBD>: Not 0390.5, 0390.6, 0390.9, 0390.10, 4310.1



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Carry out the 500 hour service together with the following:

Position	Component	Type of work	Work to be carried out	See Section
0340.1	Motor hood	Inspection	Check the locking of the motor hood	
0340.2	Motor hood	Lubrication	Motor hood hinges	
0350.1	Support arms	Lubrication	Beam contact surfaces for reach carriage rollers	
0350.2	Support arms	Inspection	Check wear and fixings of the mechanical reach carriage stops	
0390.1	Battery compartment	Inspection	Visual inspection of battery locking catch wear	
0390.2	Battery compartment	Lubrication	The locking pin for the battery catch	
0390.4	Battery compartment	Lubrication	Support arm/roller bed sliding surfaces	
0390.5	Battery compartment	Inspection	Roller bed locking (Option)	
0390.6	Battery compartment	Inspection	Wear on the roller bed sliding blocks (Option)	
0390.9	Battery compartment	Inspection	Inspect the sliding surfaces in the unloading mechanism	
0390.10	Battery compartment	Lubrication	The sliding surfaces in the unloading mechanism	
0620.1	Operator compartment	Inspection	Operator's seat mounting and adjustment functions	
0840.1	Chassis	Inspection	Tilt stop wear and sealing	
2550.1	Gear	Lubrication	Chain gear rim (after careful cleaning)	
3180.1	Wheel brake	Inspection	Brake disc wear	
3180.2	Wheel brake	Adjustment	Play in un-braked position	
3180.3	Wheel brake	Inspection	Braking force	
3180.4	Wheel brake	Check on tightening torque	Locking screw of the wheel brake in the supporting arm (34 Nm)	
3370.1	Parking brake	Inspection	Play in un-braked position	

Maintenance

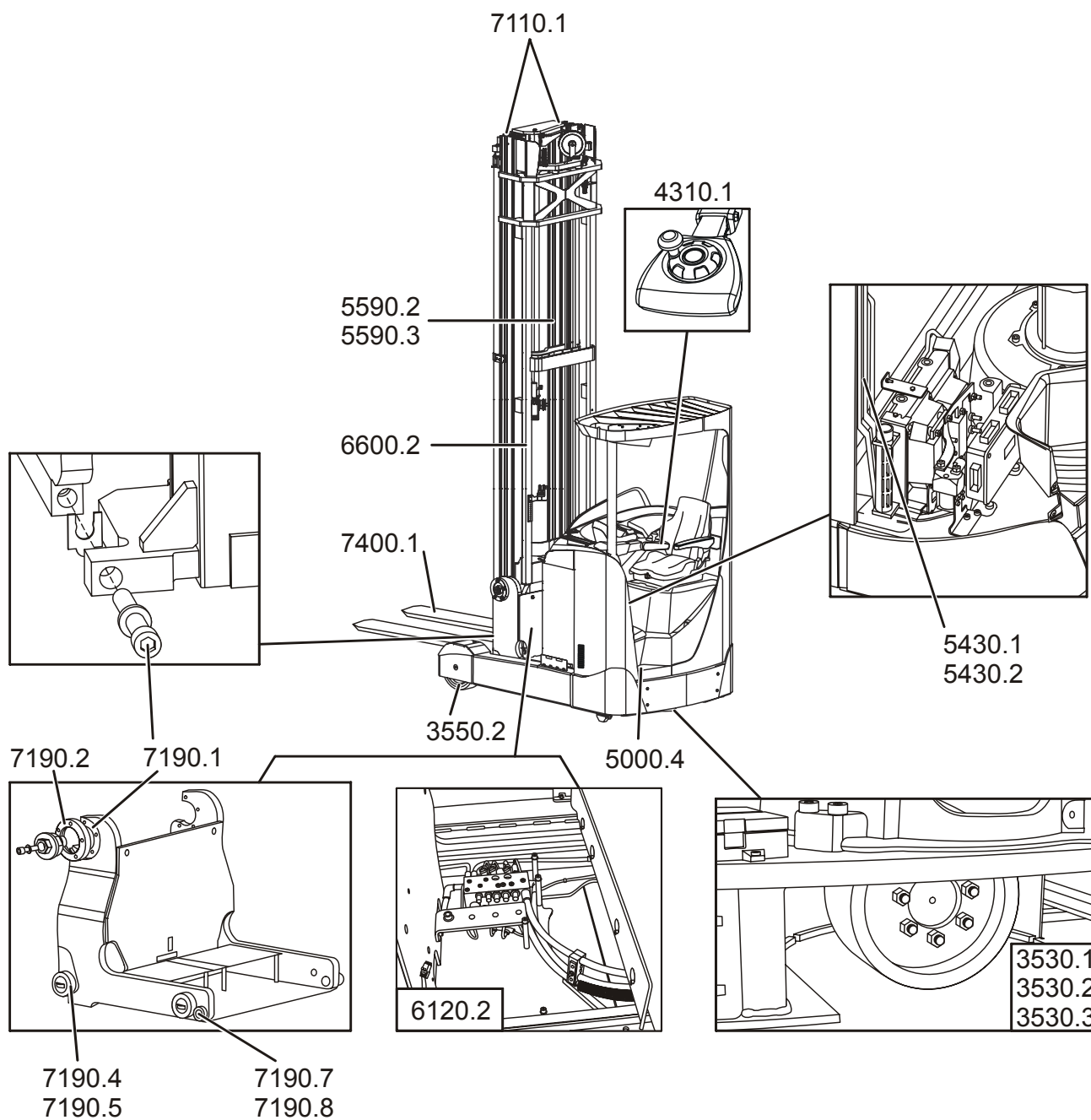
Periodic maintenance

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Position	Component	Type of work	Work to be carried out	See Section
3530.1	Wheel	Cleaning	Remove string and other debris	
3530.2	Wheel	Inspection	Tread depth wear	
3530.3	Wheel	Check on tightening torque	Wheel bolts (140 Nm)	
3550.2	Wheels	Inspection	Tread wear	
4310.1	Steering module	Inspection	Mounting and locking	
5000.4	Electrical system	Inspection	Emergency operation functions, and check that the power switch on the fuse box releases the parking brake	
5430.1	Electrical system	Inspection	Wear and damage to copper bars	
5430.2	Electrical system	Check on tightening torque	Copper bar mountings	
5590.2	Electrical system	Inspection	Wear to the mast cabling	
5590.3	Electrical system	Inspection	Restrictions (strain) on mast cabling	
6120.2	Hydraulic system	Inspection	Wear on hoses in the reach carriage and mast	
6600.2	Hydraulic system	Inspection	Mountings of the hydraulic cylinders	
7110.1	Mast	Lubrication	Play reducer and mast beams	
7190.1	Mast	Check on tightening torque	Mast fixing points, upper and lower	
7190.2	Mast	Inspection	Eccentric ring position in the upper mast fixing - should not have rotated	
7190.4	Reach carriage	Adjustment	Play of guide rollers	
7190.5	Reach carriage	Lubrication	Guide rollers	
7190.7	Reach carriage	Adjustment	Eccentric rollers	
7190.8	Reach carriage	Lubrication	Eccentric rollers	
7400.1	Forks	Inspection	Cracks	

Maintenance

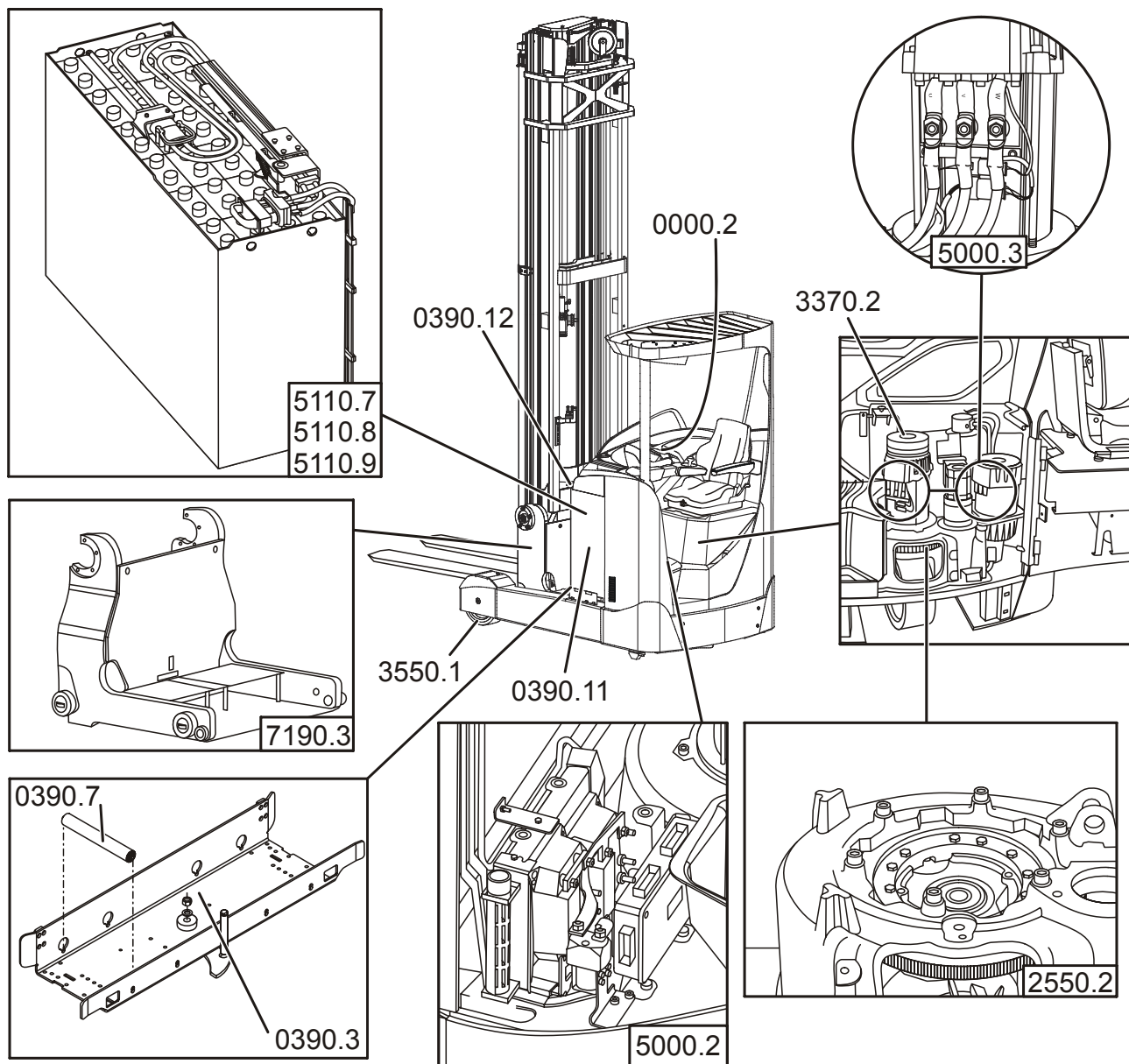
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6.2.3 Every 2000 B-hours/720 days

Estimated duration: 168.8 min.

<TBD>: Not 0390.3, 0390.7, 0390.11, 0390.12, 3550.1, 5000.2, 5110.7, 5110.8, 5110.9, 7190.3

Carry out the 500 and 1000 hour service together with the following:

Position	Component	Type of work	Work to be carried out	See Section
0000.2	Chassis	Inspection	Cable fixings	
0390.3	Battery compartment	Check on tightening torque	Fixed component of the battery lock hook	
0390.7	Battery compartment	Inspection	Bearings of the battery rollers	
0390.11	Battery compartment	Inspection	Battery changing function	
0390.12	Battery compartment	Inspection	Wear on protective housing over battery	
3550.1	Wheels	Inspection	Rotation and bearing noise	
5000.2	Electrical system	Inspection	The mountings of the electric panel	
5110.7	Battery	Inspection	Force required to withdraw the battery connector	
5110.8	Battery	Inspection	Connection of the battery connector to the copper bars	
5110.9	Battery	Inspection	Wear on battery tray guiding elements	
7190.3	Reach carriage	Inspection	Wear and bearings of reach carriage guide rollers	

6.2.4 Every 3000 B-hours/1080 days

Estimated duration: 171,8 min

<TBD>: Not 5000.3

Carry out the 500, 1000 and 2000 hour service together with the following:

Position	Component	Type of work	Work to be carried out	See Section
2550.2	Drive gear	Check on tightening torque	The gear's mounting bolts in the chassis	
3370.2	Parking brake	Inspection	Braking force	
5000.3	Electrical system	Check on tightening torque	Power cables on transistor regulators	

Maintenance

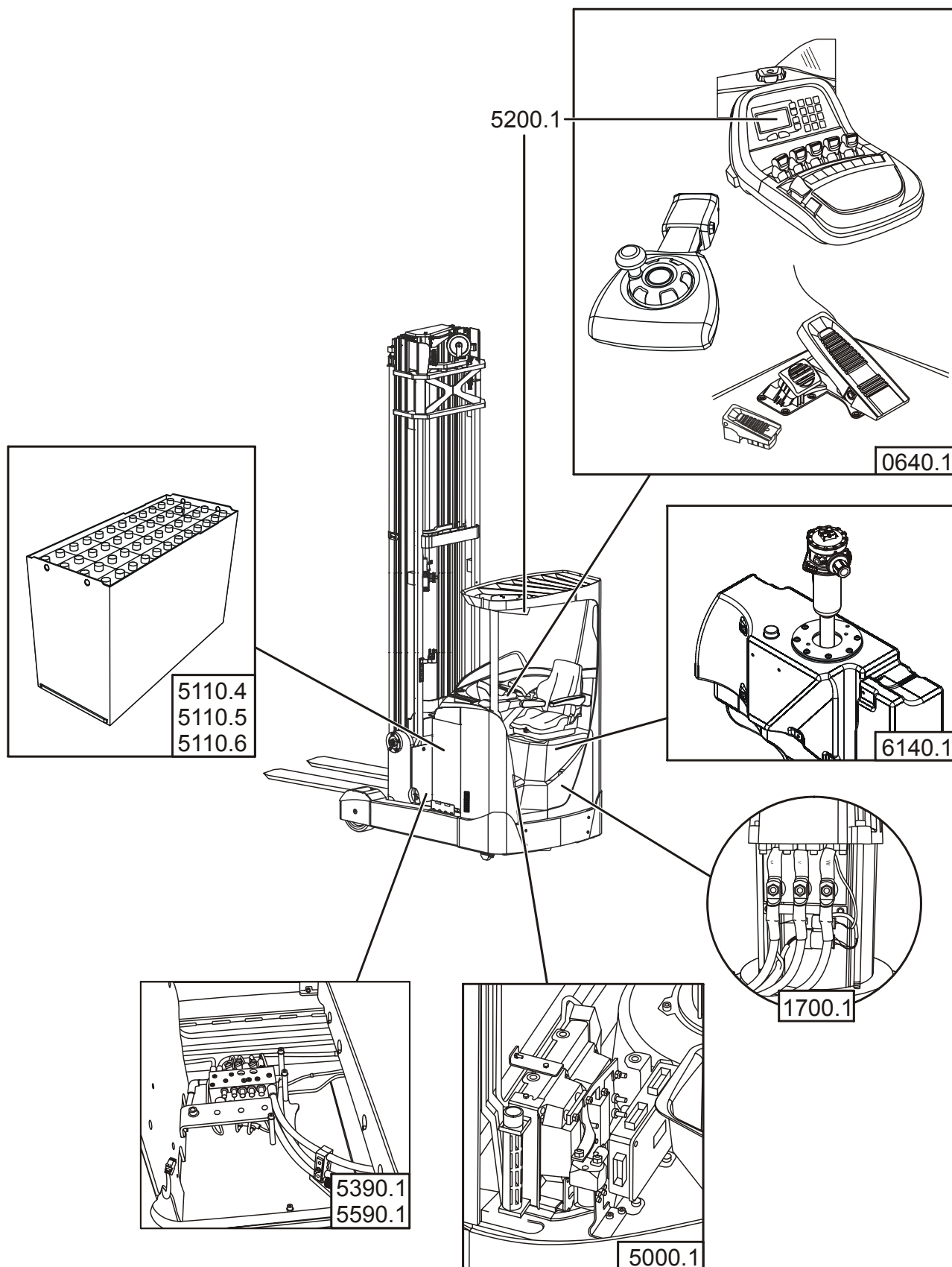
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6.2.5 Every 5000 B-hours/1800 days

Estimated duration: 175.8 min.

Carry out the 500, 1000, 2000 and 3000 hour service together with the following:

Position	Component	Type of work	Work to be carried out	See Section
6140.1	Hydraulic system	Replacement	Oil and air filter	

6.2.6 Annual status inspection

Estimated duration: 12.5 min.

<TBD>: Not 5590.1

Position	Component	Type of work	Work to be carried out	See Section
0640.1	Operator compartment	Inspection	Functions relating to control, steering wheel, brake, pedals, horn and emergency switch off	
1700.1	Motors	Check on tightening torque	Power cable connections. Tightening torque.	
5000.1	Electrical system	Cleaning	Electric panel	
5110.4	Battery	Inspection	Measure the battery fluid density with a density meter	
5110.5	Battery	Inspection	Measure the battery temperature at the centre of the battery	
5110.6	Battery	Cleaning	Remove excess fluid from the battery tray	
5200.1	Electrical system	Inspection	Wear and damage to the truck displays	
5390.1	Electrical system	Inspection	Wiring harness wear	
5590.1	Electrical system	Inspection	Wear and damage to wiring harness, including protective covering, in the reach carriage	

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6.3 Maintenance instructions

6.3.1 Cleaning and washing

Cleaning and washing the truck is important for reliability.

- Carry out general cleaning and washing each week.

IMPORTANT!

Risk of short-circuiting.

The electrical system can get damaged.

Pull out the battery connector to disconnect the battery before washing.

High-pressure washers

High-pressure washers may only be used on metal surfaces.

Under no circumstances may high-pressure washers be used in the truck motor compartment.

When using a high-pressure washer, the jet must be directed in such a way as not to damage electric cables, electric sensors, hydraulic hoses or decals.

Lifting chains, piston rods and end pieces of hydraulic cylinders, ball and roller bearings – including those that are fully enclosed – may not be exposed to the jet, as there is a risk that water may penetrate and cause corrosion.

Once washing by high-pressure washer is completed, all the truck bearings and chains must be lubricated/greased as specified in the maintenance instructions.

Degreasing agents

When using degreasing agents, only environmentally friendly cold degreasing agents may be used, such as are designed for general vehicle cleaning, and which do not damage paintwork, plastic components, cables, hydraulic hoses or decals.

Cleaning the exterior

- On a daily basis, remove rubbish, etc. from the wheels
- Degreasing agents can be used as needed, in line with the previous section
- Rinse off loose dirt with tepid water.

IMPORTANT!

Jamming, corrosion.

Mechanical parts can be damaged.

After washing the truck it should be lubricated as set out in the maintenance instructions.

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Cleaning the chain

If a chain is very dirty you are recommended to replace it.

Dirty chains should be cleaned before they are lubricated, e.g. by washing with a solvent such as diesel or petrol.

The chain should be blown dry using compressed air and lubricated directly after cleaning

IMPORTANT!

Take care with degreasing agents as these may contain abrasives.

Cleaning the motor compartment

- Cover the electric motors, connections and valves before washing

IMPORTANT!

Risk of short-circuiting.

The electrical system can get damaged.

Electrical components must not be washed with high-pressure cleaners.

- Clean the motor compartment using a leading brand of degreasing agent, diluted to a suitable concentration
- Rinse off loose dirt with tepid water.

Electrical components

- Blow electric motors clean using compressed air
- Clean electrical panels, PCBs, contactors, contacts, solenoid valves, etc., with a moist cloth and a cleaning agent.

IMPORTANT!

Risk of short-circuiting.

The electrical components may become damaged.

Do not break the warranty seal on the PCBs.

Maintenance

Maintenance instructions

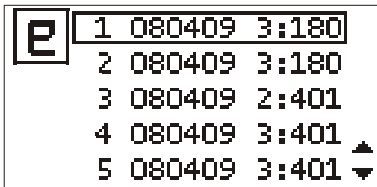
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7 – Troubleshooting

7.0.1 Error log menu



e	1	080409	3:180
	2	080409	3:180
	3	080409	2:401
	4	080409	3:401
	5	080409	3:401

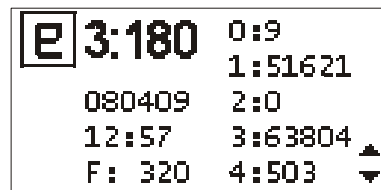
The error log displays a list of the last 20 errors logged.

Five errors are listed directly on the menu. The log number, date and error code are displayed for each error. The selected error is highlighted by means of a box that can be moved up or down the list using the arrow keys. When the selection approaches the top or bottom of the list, the menu rolls the list on, to display more errors if there are any. Pressing the green button (I) displays a new menu, the error information menu, which displays more information relating to the error selected.

Error information menu

The error information menu displays more detailed information relating to the logged error.

The error code (3:180) is shown on the left of the window. Beneath it are the log date (080409) and time (12:57) when the error occurred.



e	3:180	0:9
		1:51621
	080409	2:0
	12:57	3:63804
	F: 320	4:503

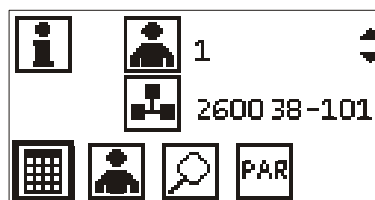
The window also contains logged information relating to the error.

Only five values are displayed at a time; to obtain more values, the arrow keys must be used.

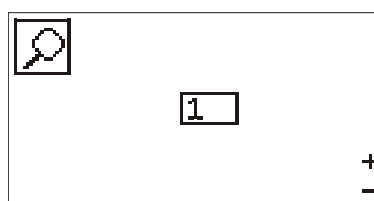
7.1 Service diagnostics menu

7.1.1 General

The service diagnostics menu can only be accessed when a service key is connected to CAN. From the operator information menu, highlight the symbol with a magnifying glass and press the green button (I).



Toggle between the numbered diagnostics states using the plus/minus buttons, and select a state using the green button (I). You can also use the numerical keys to access a given diagnostics state directly.



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7.1.2 Diagnostics states

IMPORTANT!

Please note that the updating frequency for data is slow, once a second.

State 1 – Voltage from levers

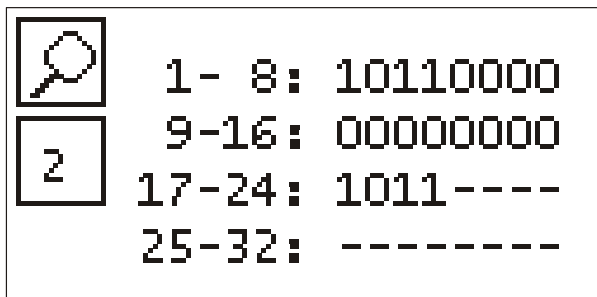
State 1 displays the voltage from the levers and travel direction selector on the control panel. The value is displayed in volts to 2 decimal places.

	1: 2.50	6: 2.60
	2: 2.44	7: 0.00
	3: 2.58	8: 0.00
	4: 2.60	9: --
	5: 2.58	10: --

No.	CID signal		
1	A1	X505:2	Lift/lowering lever
2	A2	X505:11	Reach movement lever
3	A3	X505:17	Tilt lever
4	A4	X505:3	Sideshift lever
5	A5	X505:12	Forkspread lever
6	A6	X505:4	Travel direction selector
7	A7	X505:6	–
8	A8	X505:15	–
9–10	Not used		

State 2 – Digital signals from truck controls to MCU



State 2 displays 20 digital signals from the truck controls to the CID.



No	CID signal		
1	PT0	X504:13	Steer sensor 1 A
2	PT1	X504:4	Steer sensor 1 B
3	PT2	X504:11	Steer sensor 2 A
4	PT3	X504:2	Steer sensor 2 B
5	DI5	X503:6	Free
6	DI6	X505:5	Horn
7	DI7	X503:2	Height pre-selector
8	DI8	X503:8	Height preselector override
9	DI9	X503:3	0-position tilt
10	DI10	X503:9	0-position sideshift
11	DI11	X503:4	Extra function 5th lever
12	DI12	X503:10	Cabin tilt
13	DI13	X503:5	Free
14	DI14	X503:11	Free
15	DI15	X504:10	Flashers, left
16	DI16	X504:1	Flashers, right
17	DI17	X505:14	(Multi/Single Keying)
18	DI18	X503:12	Free
19	ESOIN	X504:16	Emergency stop (ESO)
20	KEYIN	X504:7	Key signal

State 3 – Voltages to MCU



State 3 displays the voltage to the MCU from 10 analogue controls and sensors on the truck. The value is displayed in volts to 2 decimal places.

	1: 0.00	6: 1.48
	2: 0.00	7: 0.50
	3: 0.00	8: 4.50
	4: 0.77	9: 0.00
	5: 0.50	10: 51.21

No.	MCU signal		
1	A1	X130:2	–
2	A2	X130:16	Fork tilt indicator
3	A3	X130:30	Hydraulic pressure, main lift
4	A4	X130:3	Hydraulic pressure, free lift
5	A5	X130:17	Accelerator
6	A6	X130:31	Safety pedal
7	A7	X130:4	Brake pedal 1
8	A8	X130:18	Brake pedal 2
9	A9	X130:32	Power consumption
10	A10	X130:5	Battery voltage +

State 4 – Digital input signals to MCU

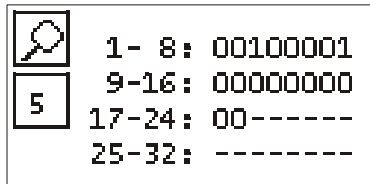
State 4 displays 25 digital input signals to the MCU.

	1- 8: 00110110
	9-16: 00001000
	17-24: 00000000
	25-32: 0-----

No.	MCU signal		
1	DI1	X130:10	Cabin tilt, upper position
2	DI2	X130:24	Cabin tilt, lower position
3	DI3	X130:38	Reach movement, position 1
4	DI4	X130:11	Reach movement, position 2
5	DI5	X130:25	Steering angle, 180 degrees
6	DI6	X130:39	Mast lowering mode A
7	DI7	X130:12	Main lift height A (with height indicator)/ Mast near bottom position (without height indicator)
8	DI8	X130:26	Main lift height B
9	DI9	X130:40	Free lift height A
10	DI10	X130:13	Free lift height B
11	DI11	X130:27	Mast lowering mode B
12	DI12	X130:41	Seat switch
13	DI13	X131:2	Forks below 1 m (with height indicator)/ Forks near top of mast (without height indicator)
14	DI14	X131:16	Travel direction pedal, drive wheel direction
15	DI15	X131:30	Travel direction pedal, fork direction
16	DI16	X131:3	Free
17	DI17	X131:17	Speed limitation 1
18	DI18	X131:31	Speed limitation 2
19	DI19	X131:4	Speed limitation 3
20	DI20	X131:18	Sideshift, left
21	DI21	X131:32	Sideshift, right
22	DI22	X131:5	Emergency stop (ESO)
23	DI23	X131:19	Key (option)
24	DI24	X131:33	(production test)
25	DI25	X131:6	Key signal in

State 5 – Digital output signals from MCU

State 5 displays 18 digital output signals from the MCU.



No	MCU signal		
1	DO1	X131:20	Parking brake
2	DO2	X131:34	Chassis fan
3	DO3	X131:7	Main contactor
4	DO4	X131:21	Extra (Aux) hydraulic function valve 2
5	DO5	X131:35	Flashers, right
6	DO6	X131:8	Flashers, left
7	DO7	X131:22	Travel alarm 2
8	DO8	X131:36	Warning lamp
9	DO9	X131:9	Fan inverter
10	DO10	X131:23	Travel alarm 1
11	DO11	X131:37	Extra (Aux), direction A
12	DO12	X131:10	Extra (Aux) hydraulic function valve 3
13	DO13	X131:24	Extra (Aux) hydraulic function valve 4
14	DO14	X131:38	Extra (Aux) hydraulic function valve 1
15	DO15	X131:11	Extra (Aux), direction B
16	DO16	X131:25	Horn
17	DO17	X131:39	Support arm brake, left
18	DO18	X131:12	Support arm brake, right

Troubleshooting

Service diagnostics menu

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State 6 – PWM outputs from MCU

State 6 displays 10 pulse modulated (PWM) output signals from the MCU. The value is displayed in volts to 2 decimal places.

	1: 0.00	6: 0.00
	2: 0.00	7: 0.00
	3: 0.00	8: 0.00
	4: 0.00	9: 0.00
	5: 0.00	10: 0.00

No	MCU signal		Unit	
.				
1	PWM1	X131:26	V	Main Lift
2	PWM2	X131:40	V	Main lowering
3	PWM3	X131:13	V	Reach movement, in
4	PWM4	X131:41	V	Reach movement, out
5	DO17	X131:39	V	Support arm brake, left
6	DO18	X131:12	V	Support arm brake, right
	ACH signal			
7	PWM1	K1:10	A	Free lift
8	PWM2	K1:2	A	Free lowering
	ACT signal			
9	PWM1	K1:10	A	Cabin tilt, up
10	PWM2	K1:2	A	Cabin tilt, down

State 7 – FCU (not used)



State 8 – FCU (not used)

State 9 – GFU (not used)

State 10 – GFU (not used)

State 11 – Temperature signals



State 11 displays the temperature signals in the truck, of which there are 5 in total. The value is displayed in degrees Celsius.

	1: 20
	2: 18
	3: 20
	4: 17
	5: 21

No	Temperature
.	
1	ACT motor temperature
2	ACT cooler plate temperature
3	ACH motor temperature
4	ACH cooler plate temperature
5	EPS motor temperature

State 12 – Voltage levels

State 12 displays 6 different voltage levels in the truck. The value is displayed in volts to 2 decimal places.

	1: 51.15	6: 51.31
	2: 14.96	7: --
	3: 5.00	8: --
	4: 51.11	9: --
	5: 51.20	10: --

No.	Voltage
1	MCU battery voltage
2	15 V external voltage
3	5 V external voltage
4	ACH battery voltage
5	ACT battery voltage
6	EPS battery voltage
7-10	Free

Troubleshooting

Service diagnostics menu

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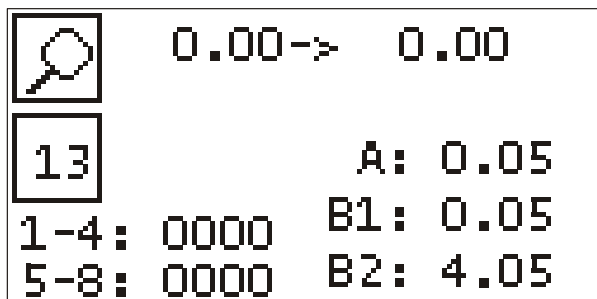
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State 13 – Travel information

State 13 displays travel information.




No.		Unit
	Travel speed, target	m/s
	Travel speed, actual	m/s
A	Accelerator	V
B1	Brake pedal	V
B2	Brake pedal	V
1	Main contactor	
2	ACT power stage enabled	
3	Safety pedal/door switch	
4	Seat switch	
5	Parking brake enabled	
6-8	Not used	

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State 14 Steering information

State 14 displays steering information.

	350 -> 350°
	0 -> 0rpm
14	
1-4: 0001	S1: 0
5-8: 0000	S2: 0

No.		Unit
	Position, target	°
	Position, actual	°
	Steering speed, target	V/min
	Steering speed, actual	V/min
S1	Steering command	%
S2	Steering command	%
1	MCU reference sensor	
2	EPS reference sensor	
3	Target drive wheel direction	
4	Target fork direction	
5	Steering command reversed	
6-8	Not used	

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Service diagnostics menu

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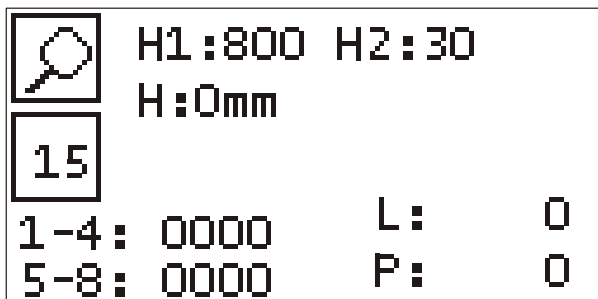
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State 15 – Lift/lowering information

State 15 displays lift/lowering information.





No.		Unit
H1	Height, free lift	mm
H2	Height, main lift	mm
H	Height, total (displayed)	mm
L	Lift/lowering lever	V
P	Requested hydraulic pump speed	rpm
Basic version, height indicator (parameter 1009 = 0)		
1	Mast lowered pos. A	
2	Mast lowered pos. B	
3		
4	Mast near to lowered pos.	
5	ACH power stage enabled	
6		
7		
8	Forks near to mast top	
Full height indication (parameter 1009 = 1)		
1	Mast lowered pos. A	
2	Mast lowered pos. B	
3		
4		
5	ACH power stage enabled	
6		
7		
8	Free lift, height reference	

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State 16 – Reach movement

State 16 displays reach movement information.

	R : 240mm
	PAR : 456mm
	
1-4 : 0000	L : 0
5-8 : 0000	P : 0

No.		Unit
R	Actual reach movement length	mm
PAR	Parameter 1265, maximum reach movement length	mm
L	Reach movement lever	V
P	Requested hydraulic pump speed	rpm
1	Reach carriage sensor 1	
2	Reach carriage sensor 2	
3-8	Not used	

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Service diagnostics menu

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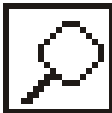

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State 17 – Hydraulic information

State 17 displays hydraulic information.

	FT : -32
	L1 : -36
	L2 : 0
	L3 : 0
1-4 : 0000	P : 105
5-8 : 0000	

No.		Unit
FT	Fork tilt, angle	0.1 degrees
L1	Lever aux 1	V
L2	Lever aux 2	V
L3	Lever aux 3	V
P	Requested hydraulic pump speed	rpm
1	Ergo cabin, upper position	
2	Not used	
3	Sideshift sensor, left-hand side	
4	Sideshift sensor, right-hand side	
5	Ergo cabin, lowered position	
6-8	Not used	

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7.2 Warning and error codes

Abbreviations used in this section

ACH	(AC Hydraulic) Pump Control (T2)
ACT	(AC Traction) Travel Control (T1)
CID	Central Information Display (A1)
EPS	(Electronic Power Steering) Steering Servo (A2)
FCU	Fork Control Unit
GFU	General Function Unit (A8)
LID	Load Information Display (P6)
MCU	Main Control Unit (A5)

Error code structure

The error codes consist of warnings and errors. An error code consists of two parts, a group number and a code number, separated by a colon (:), for instance: 1:181.

By studying the tables below we can read off that the error code originates from the CID (1:nnn), in the form of a warning (n:1nn) and relates to a signal error from a sensor (n:n81). The sensor in question can be identified using the error code tables in this section.

All codes start with a main group, 1–7, depending on the system they belong to.

Group number, error codes	
Group:	Description
1:nnn	CID
2:nnn	MCU
3:nnn	Traction force system
4:nnn	Hydraulic system
5:nnn	Steering system
6:nnn	Wire guidance (does not apply to RRE trucks)
7:nnn	GFU

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The first digit of the three-digit error code indicates the severity of the error and how the truck is affected/responds when the error occurs.

Code number	Error category/action taken
n:0nn	Caution. Generally an information code. No action to be taken on the truck.
n:1nn	Warning. Some functions may be disabled or reduced. See the specific error code to see what action has been taken.
n:2nn	Error. All parts of the hydraulic system are disabled. See the specific error code to see what action has been taken.
n:3nn	Error. The truck is braked by the motor and/or the support arm brake and/or the parking brake until it comes to a halt. It is not possible to drive it. The steering may be disabled if there is a steering error. To see what action has been taken, see the specific error code.
n:4nn	Error. The truck is braked by the motor brake until it stops. Once the truck has stopped, or after 5 seconds, the relays for the main power supply and key are switched off.
n:5nn	Critical error. Main contactor and power relay for the key are switched off.

The error codes are subdivided into smaller categories based on the last two digits of the code (see below).

Error code, type of error	
Code number	Description
n:n00–n09	Miscellaneous error codes.
n:n10–n19	CAN-related error codes.
n:n20–n39	Error codes related to specific units.
n:n40–n59	Error codes for short-circuited output data.
n:n60–n79	Error codes for output data from open electrical circuits.
n:n80–n99	Faulty signals from sensors.

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7.2.1 Error codes

Code	Name	Description/possible causes
	Event	Action
Group 1 CID warnings and errors		
1:003	Minor program version incompatibility	The program versions in the MCU and CID do not match. The MCU does not support some of the functions used by the CID, or vice versa.
		Check that identical versions of the software are being used in the CID and MCU.
1:004	Incompatibility in the display program software	The program versions in the MCU and CID do not match. The MCU does not support some of the functions used by the CID, or vice versa.
		Check that identical versions of the software are being used in the CID and MCU.
1:010	CAN 1 communication warning	The CID CAN module has received too many error messages.
		1. Check that CAN 1 is intact in terms of wiring harness, final resistance and contacts. 2. Withdraw the battery contact. Check that the resistance between positions 3 and 4 in X41 is 54 – 66 ohms. 3. Uninstall and disconnect the LID.
1:120	LID status does not comply	LID reports status that is not approved.
1:121	CAN 1 communication warning	Communication with the LID lost. No message received from the LID.
1:431	External +5 V error	The external +5 V is outside the permitted voltage range.
		1. Check the electrical supply in terms of wiring harness and contacts. 2. Check that there is no short circuit between B31:1 and B31:3. 3. Disconnect levers and buttons, one by one, from the wiring harness connected to X505:1.
1:501	MCU error	The CID detects an error in the MCU. The program counter is not correct.
		Look for the latest software, replace the MCU.
1:503	Emergency mode error	The MCU and CID display different status if the truck is in emergency driving mode.
		Restart the truck.

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Code	Name	Description/possible causes
	Event	Action
1:504	Major program version incompatibility	The program versions in the MCU and CID do not match. The MCU does not support some of the functions used by the CID, or vice versa.
	Login not permitted	Check that identical versions of the software are being used in the CID and MCU.
1:510	CAN 1 communication error	CID CAN BOF. CAN bus error.
1:512	CAN 1 communication error	The CID has problems sending a CAN message
		<ol style="list-style-type: none"> 1. Check that CAN 1 is intact in terms of wiring harness, final resistance and contacts. 2. Withdraw the battery contact. Check that the resistance between positions 3 and 4 in X41 is 54 – 66 ohms. 3. Uninstall and disconnect the CID.
1:514-1:516	CAN 1 communication error	The MCU or CID have not received a response via CAN in 70 ms.
		<ol style="list-style-type: none"> 1. Check that CAN 1 is intact in terms of wiring harness, final resistance and contacts. 2. Withdraw the battery contact. Check that the resistance between positions 3 and 4 in X41 is 54 – 66 ohms. 3. Uninstall and disconnect the CID.
1:520	Internal 5 V error	The internal 5 V is outside the permitted voltage range.
		Check the power supply, cables.
1:540	Key contactor interrupted power circuit	
		<ol style="list-style-type: none"> 1. Check that the wiring harness and contacts are intact and correctly fitted. 2. Check the operation of the key contactor. 3. Replace the MCU.
1:580	Key contactor welded	
		<ol style="list-style-type: none"> 1. Check that the wiring harness and contacts are intact and correctly fitted. 2. Check the operation of the key contactor. 3. Replace the MCU.
1:581	Key contactor off	
		<ol style="list-style-type: none"> 1. Check that the wiring harness and contacts are intact and correctly fitted. 2. Check the operation of the key contactor. 3. Replace the MCU.

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Code	Name	Description/possible causes
	Event	Action
Group 2 - MCU and non-classified warnings and errors		
2:002	Standard value warning	The standard factory value has been loaded on the MCU.
		Check that the truck settings suit the required application.
2:003	Internal MCU error	Error on reading back-up data.
	Possible error on hour meter and error log	Carry out back-up of data. Update to the latest program software. If necessary, replace the MCU unit.
2:004	The back-up parameters do not match.	The back-up data does not match. Error when control value is tested.
2:005	Time for service	
2:006	LOG buffer overfull	Only logged, not displayed. Errors that should have been logged have disappeared from the error log.
2:010	CAN 1 communication warning	The MCU CAN module has received too many error messages.
		<ol style="list-style-type: none"> 1. Check that CAN 1 is intact in terms of wiring harness, final resistance and contacts. 2. Withdraw the battery contact. Check that the resistance between positions 3 and 4 in X41 is 54 – 66 ohms. 3. Uninstall and disconnect the CAN 1 modules, one after the other.
2:011	CAN 2 communication warning	The MCU CAN module has received too many error messages.
		<ol style="list-style-type: none"> 1. Check that CAN 2 is intact in terms of wiring harness, final resistance and contacts. 2. Withdraw the battery contact. Check that the resistance between positions 8 and 22 in X130 is 54 – 66 ohms. 3. Uninstall and disconnect the CAN 2 modules, one after the other.
2:102	HPS stop height	Error on height preselector, stop height.
2:103	Lift height limiting	Lift height limiting is activated but no height measurement is activated.
2:106	Collision locking	Collision value registered over the level determined by the service parameter, a collision has been registered.
	Travel speed reduced	

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Code	Name	Description/possible causes
	Event	Action
2:140	Error on digital output signal 2	Output signal for chassis fan short-circuited.
		1. Check the power supply, contacts and wiring harness with regard to a short circuit. 2. Check the operation of the chassis fan.
2:141	Error on digital output signal 9	Output signal for fan voltage converter short-circuited.
		1. Check the power supply, contacts and wiring harness with regard to a short circuit. 2. Check the operation of the voltage converter.
2:160	Error on digital output signal 2	Cable break output signal for chassis fan.
		1. Check the power supply, contacts and wiring harness with regard to a short circuit. 2. Check the operation of the chassis fan.
2:161	Error on digital output signal 9	Cable break output signal for fan voltage converter.
		1. Check the power supply, contacts and wiring harness with regard to a short circuit. 2. Check the operation of the voltage converter.
2:180	CAN 1 communication warning	Impact sensor error. No contact with impact sensor.
	Travel speed reduced	1. If impact sensor is not present, change parameter 109/110 to deactivate the impact sensor. 2. Check the power supply, contacts and wiring harness.
2:401	Internal program error MCU	Error in the MCU program.
		Program software error, report to BT.
2:403	Read A/D time-out	A/D reading is taking too long.
2:420	Incorrect battery voltage	The battery voltage is below 33.6 V.
		1. Check the battery status. 2. Check that the battery cables are intact and correctly fitted. 3. Check that the battery status wiring harness is intact and correctly fitted.
2:421	Incorrect battery voltage	Battery voltage exceeds 72 V.
		1. Check the battery status. 2. Check that the battery cables are intact and correctly fitted. 3. Check that the battery status wiring harness is intact and correctly fitted.

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Code	Name	Description/possible causes
	Event	Action
2:431	External + 5 V error	5 V electrical supply for external sensors is under 4.9 V.
		1. Check that the cables are intact and correctly fitted. 2. Check external loads, e.g. faulty sensors, short circuits. Disconnect them one by one.
2:432	External + 5 V error	5 V electrical supply for external sensor exceeds 5.1 V.
2:433	External + 15 V error	15 V electrical supply for external sensor is under 12 V.
		1. Check that the cables are intact and correctly fitted. 2. Check external loads, e.g., faulty sensors, short circuits. Disconnect them one by one.
2:434	External + 15 V error	15 V electrical supply for external sensor exceeds 16.5 V.
2:435	Internal + 7.5 V error	7.5 V electrical supply for internal circuits is under 7 V.
		Check electrical supply to the MCU.
2:436	Internal + 7.5 V error	7.5 V electrical supply for internal circuits exceeds 8 V.
		Check electrical supply to the MCU.
2:437	Frequency converter low	Frequency converter voltage is under 12 V.
2:438	Frequency converter high	Frequency converter voltage exceeds 62 V.
2:501	Check sum error	The check sum is not correct.
2:502	General internal program error in MCU	Program error in the MCU program.
		Report to BT.
2:504	Emergency mode error	The MCU and CID display different status if the truck is in emergency driving mode.
		Restart the truck.
2:505	Program calculator	The program calculator is not consistent.
2:507	Truck immobile	Truck set in "unusable" mode.
2:510	CAN 1 error	Error on initiation of CAN 1.
		1. Check that CAN 1 is intact in terms of wiring harness, final resistance and contacts. 2. Withdraw the battery contact. Check that the resistance between positions 3 and 4 in X41 is 54 – 66 ohms. 3. Uninstall and disconnect the CAN 1 modules, one after the other.

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Code	Name	Description/possible causes
	Event	Action
2:511	CAN 2 error	
		<ol style="list-style-type: none"> 1. Check that CAN 1 is intact in terms of wiring harness, final resistance and contacts. 2. Withdraw the battery contact. Check that the resistance between positions 8 and 22 in X130 is 54 – 66 ohms. 3. Uninstall and disconnect the CAN 2 modules, one after the other.
2:512	CAN 1 communication error	The MCU has problems with sending messages via CAN 1.
		See 2:510.
2:513	CAN 2 communication error	The MCU has problems with sending messages via CAN 2.
		See 2:511.
2:514	DHU login error	No response to login received from DHU/TWIS.
		Check that the login settings (parameters) are correct. Check the DHU with regard to wiring harness and power supply.
2:523	Battery current is high	The current from the battery exceeds 800 A.
2:531	Internal + 5 V error	Internal 5 V electrical supply is under 4.9 V
		Replace the MCU.
2:532	Internal + 5 V error	Internal voltage 5 V electrical supply exceeds 5.5 V
		Replace the MCU.
2:533	Internal + 15 V error	Internal voltage 15 V electrical supply is under 14.25 V
		Replace the MCU.
2:534	Internal + 15 V error	Internal voltage 15 V electrical supply exceeds 15.75 V
		Replace the MCU.
2:537	Internal + V O error	+V O electrical supply for digital output signals is under 9.7 V.
		Check electrical supply to the MCU.
2:538	Internal + V O error	+V O electrical supply for digital output signals is over 12 V.
		Check electrical supply to the MCU.
2:540	Error on digital output signal 3	Output signal for main contactor has been short-circuited.
		<ol style="list-style-type: none"> 1. Check the magnetic coils, the electrical supply, contacts and wiring harness with regard to a short circuit. 2. Check that the main contactor works. 3. Replace the MCU.

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Code	Name	Description/possible causes
	Event	Action
2:555	Time out for start-up	Not all modules started within 20 seconds.
		Check that the truck wiring harness with contacts is intact and correctly fitted.
2:556	Time out for shutdown	Not all modules been shut down within 20 seconds.
2:560	Error on digital output signal 3	Cable break output signal for main contactor.
		Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal X131:7.
2:580	Main contactor error	Main contactor welded.
		Check the main contactor, X131:7 and the wiring harness. Restart of the truck in the emergency mode position is necessary to reset the error.
2:581	Main contactor error	Main contactor activated but not read as closed.
		Check the main contactor, X131:7 and the wiring harness.
2:582	Main contactor error	The frequency converter with PTC is under 36 V.
		Check the wiring harness from the MCU to the ACS.
Group 3 Travel system		
3:080	Safety pedal more than 20 minutes	Safety pedal activated more than 20 minutes.
		Check that the signal does not exceed 2.5 V when the pedal is released and that the signal changes when the pedal is engaged.
3:142	MCU output 5, signal error.	The left-hand support arm brake is short-circuited.
	Driving speed is reduced, 13 and 7 km/hour in driving and fork direction respectively.	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal X131:39.
3:143	MCU output 6, signal error.	The right-hand support arm brake is short-circuited.
	See 3:142.	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal X131:12.
3:162	MCU output 5, signal error.	Cable break, left-hand support arm brake.
	See 3:142.	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal X131:39.
3:163	MCU output 6, signal error.	Cable break, right-hand support arm brake.
	See 3:142.	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal X131:12.
3:180	Safety pedal	Safety pedal signal is outside the permitted value; 1.5–3.5 V
		Check the output signal X131:31.

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Code	Name	Description/possible causes
	Event	Action
3:300	Motor brake error	The motor cannot brake adequately. The ACT cannot provide sufficient power to the motor with the result that this cannot maintain the speed required. Can occur when driving on a downward incline.
	The truck is braked with the parking brake and, where present, support arm brakes. Driving deactivated.	
3:305	Temperature error	Drive motor temperature is over 180°C.
	The truck is braked to 0 km/h with the parking brake and, where present, support arm brakes.	1. Check the motor compartment fan. 2. Check the drive motor and temperature sensor. 3. No fault; may be due to intensive operation.
3:314-3:316	CAN 2 communication error.	The MCU or ACT have not received a response via CAN in 70 ms.
	See 3:305.	Check that CAN 2 is intact in terms of wiring harness, final resistance and contacts. Check that the green LED on the ACT is on.
3:320-3:322	Incorrect DC voltage	ACT DC voltage is outside the permitted voltage range.
	See 3:305.	Check the wiring harness, the fuses F1 and F71, and the main contactor. Check that the green LED on the ACT is on. Check the battery.
3:323	Overcurrent error	Overcurrent ACT.
	See 3:305.	Check that the battery has the correct voltage and that there are no short circuits.
3:325	Temperature error	The temperature on the ACT cooling plate is over 125 °C.
	See 3:305.	Check the cooling plate and clean the cooling air duct. Check the temperature sensor.
3:328	ACT short-circuited	Short circuit in the ACT, motor cables or motor.
3:329	Internal parameter error in the ACT	The displacement in the current measurement is too high.
	See 3:305.	Restart the truck. If the error remains, replace the ACT.
3:331	Internal + 5 V error.	The internal 5 V supply in the ACT is outside the permitted voltage range.
	See 3:305.	Check the electrical supply to the ACT.
3:333	Internal + 15 V error.	The internal 15 V supply in the ACT is under the permitted voltage range.
	See 3:305.	Check the electrical supply to the ACT.

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Code	Name	Description/possible causes
	Event	Action
3:380	Speed sensor error	Cable break/short circuit in the speed sensor.
	See 3:300.	Check the sensor B11 and its wiring harness.
3:385	Accelerator 1 error	The voltage from the pedal is outside the permitted range, 0.25–4.75 V.
	Operation not possible. The truck is braked by the motor brake until it stops.	Check the wiring harness, pedals and X130:17.
3:387	Brake pedal error (signal 1)	The voltage from the pedal is outside the permitted range, 0.25–4.75 V.
	See 3:385.	Check the wiring harness, pedals and X130:4.
3:388	Brake pedal error (signal 2)	The voltage from the pedal is outside the permitted range, 0.25–4.75 V.
	See 3:385.	Check the wiring harness, pedals and X130:18.
3:389	Brake pedal error	Signals 1 and 2 from the brake pedal do not conform, difference of > 1.5 V.
	See 3:385.	Check the pedals and that there is no short circuit between cables 85 and 86.
3:390	Error on the travel direction selector	The signal is outside the permitted range, 0.25–4.75 V.
	See 3:385.	Check X505:4, the travel direction selector and wiring harness.
3:500	Unexpected error	Unknown drive error.
		Check that the same versions of the software are being used in the MCU and ACT. Update to the latest version. Report to BT.
3:520	Start-up error	
3:540	Error on digital output signal 1	Output signal for parking brake short-circuited.
		Check the magnetic coil with Q1 (48 V, ~32 ohms), the electrical supply, contacts and wiring harness. Check the output signal X131:20.
3:560	Error on digital output signal 1	Output signal for parking brake, interrupted power circuit
		Check the magnetic coil with Q1 (48 V, ~32 ohms), the electrical supply, contacts and wiring harness. Check the output signal X131:20.

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Code	Name	Description/possible causes
	Event	Action
Group 4 Hydraulic system		
4:180	Height sensor error	No pulses from the main lift height sensor on lift/lowering.
	Disabled lift function	1. Check the main lift height sensor, the electrical supply and wiring harness. 2. Recalibrate valve Q4 and Q5. 3. The fork load may be too heavy on lifting.
4:181	Height sensor value invalid	The current height value for main lift does not correspond to the signal from the height reference sensor on lowering.
	Disabled lift function	Check the lift reference sensor, the main lift height sensor, the electrical supply and wiring harness.
4:182	Height sensor error	No pulses from the free lift height sensor on lift/lowering.
	Disabled lift function	Check the height sensor, the electrical supply and wiring harness. The fork load may be too heavy on lifting.
4:183	Height sensor value invalid	The current height value for free lift does not match the signal from the height reference sensor on lowering.
4:184	Abnormal lift/lowering speed	The fork speed is too high.
	Lift and lowering disabled	This error should not occur during normal operation. Check both height sensors if lift/lowering speed is working normally.
4:185	Height sensor error	The height reference signal for free lift is absent when its presence would be expected. The free lift height sensor value indicates that the height reference sensor should have changed.
	Lift/lowering speed reduced	Check the reference sensor and fork height as displayed against the actual fork height.
4:186	Height sensor error	The height reference signal for main lift is absent when its presence would be expected. The free main lift height sensor value indicates that the height reference sensor should have changed.
	Lift/lowering speed reduced	Check the reference sensor and fork height as displayed against the actual fork height.
4:187	Abnormal lift height	The calculated lift height is lower than –150 mm, or 50 mm higher than the maximum fork height according to parameter 1010.
	Lift/lowering speed reduced	Activate the reference sensors by lifting and lowering the forks. If the error remains, check all height-related parameters.

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Code	Name	Description/possible causes
	Event	Action
4:188	Error on the cabin tilt sensor	The cabin tilt sensors are emitting different values (Ergo truck).
	Tilting up of the cabin prevented.	Check the electrical supply, harness and sensors for cabin tilting.
4:189	Pressure sensor error	The pressure signal is outside the permitted range, 0.3–4.7 V.
4:189	Pressure sensor error	The pressure signal is outside the permitted range, 0.3–4.7 V.
	The program assumes the maximum load on the forks (250 bar)	Check pressure sensor B4, the electrical supply, X130:3 and wiring harness.
4:192	Mast separation sensor error	The mast separation sensors A and B have a signal combination that is not permitted.
	Lift/lowering speed reduced	Check the mast separation sensor signals, X130:39 and X130:27. They must change at the same time as the mast is separated and have opposite values.
4:193	Reach movement sensor error	No pulses from the reach movement length sensor during reach movement.
	Reduced reach movement speed	1. Check the length sensors' signal X130:38 and X130:11. If the reach carriage has reached its end position, check parameter 1265, reach movement length. 2. Recalibrate valve Q6 and Q7. 3. If the reach carriage moves too ponderously, check the adjustment of the rollers.
4:200	Unexpected error	Unknown drive error.
	Deactivated hydraulics	Check that the same versions of the software are being used in the MCU and ACH. Update to the latest version. Report to BT.
4:205	Temperature error	Pump motor temperature is over 180 °C.
	Deactivated hydraulics	1. Check the motor compartment fan. 2. Check the pump motor and temperature sensor. 3. No fault; may be due to intensive operation.
4:214– 4:216	CAN 2 communication error	The MCU or ACH have not received a response via CAN in 70 ms.
	See 4:205.	Check that CAN 2 is intact in terms of wiring harness, final resistance and contacts. Check that the green LED on the ACH is on and remains on.
4:220– 4:222	Incorrect DC voltage	ACH DC voltage is outside the permitted voltage range.
	See 4:205.	Check the wiring harness, the fuses F3 and F71, and the main contactor. Check that the green LED on the ACH is on.

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Code	Name	Description/possible causes
	Event	Action
4:223	Overcurrent error	Overcurrent ACH.
	See 4:205.	Check that the battery has the correct voltage and that there are no short circuits present.
4:225	Temperature error	The temperature on the ACH cooling plate is over 125 °C.
	See 4:205.	Check the cooling plate and clean the cooling air duct. Check the temperature sensor.
4:228	ACH short-circuited	Short circuit in the ACH, motor cables or motor.
	See 4:205.	Check the cables between the ACH and motor.
4:229	Internal parameter error in the ACH	The displacement in the current measurement is too high.
	See 4:205.	Restart the truck. If the error remains, change the ACH.
4:231	Internal + 5 V error	The internal 5 V supply in the ACH is outside the permitted voltage range.
	See 4:205.	Check the electrical supply to the ACH.
4:233	Internal + 15 V error	The internal 15 V supply in the ACH is under the permitted voltage range.
	See 4:205.	Check the electrical supply to the ACH.
4:240	Error on the free lift valve.	Short circuit in output signal for the free lift valve.
	Lift deactivated	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal (K1:10) on the ACH.
4:241	Error on the free lowering valve	Short circuit in output signal for the free lowering valve.
	Lowering of forks during free lift prevented	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal (K1:2) on the ACH.
4:242	Valve error when Ergo cabin tilted up.	Short circuit in output signal for upward tilt of operator cabin.
	Tilting up of cabin is prevented.	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal (K1:12) on the ACT.
4:243	Error on digital output signal 4.	Short circuit in output signal for AUX 2.
	Aux (extra function) deactivated.	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal (X131:21).
4:244	Error on digital output signal 12.	Short circuit in output signal for AUX 3.
	Aux (extra function) deactivated.	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal (X131:10).

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Code	Name	Description/possible causes
	Event	Action
4:245	Error on digital output signal 13.	Short circuit in output signal for AUX 4.
	Aux (extra function) deactivated.	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal (X131:24).
4:246	Error on digital output signal 14.	Short circuit in output signal for AUX 1.
	Tilt or sideshift affected	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal (X131:38).
4:247	Error on cabin tilt-down.	Short circuit in output signal for downward tilt of operator cabin.
	Cabin tilt prevented.	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the signal (K1:2) on the ACH.
4:248	Error on digital output signal 11.	Short circuit in output signal for AUX direction A.
	AUX deactivated.	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal (X131:37).
4:249	Error on digital output signal 15.	Short circuit in output signal for AUX direction B.
	AUX deactivated.	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal (X131:11).
4:250	Error on MCU output signal 1.	Short circuit in output signal for main lift valve.
	All hydraulic functions deactivated.	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal (X131:26).
4:251	Error on MCU output signal 2.	Short circuit in output signal for main lowering valve.
	All hydraulic functions deactivated.	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal (X131:40).
4:252	Error on MCU output signal 3.	Short circuit in output signal for mast reach valve.
	Reach movement deactivated	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal (X131:41).
4:253	Error on MCU output signal 4.	Short circuit in output signal for mast retraction valve.
	Reach movement deactivated	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal (X131:13).
4:260	Error on the free lift valve	Interrupted circuit in the free lift valve output signal
	Lift deactivated.	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal (K1:10).

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Warning and error codes

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Code	Name	Description/possible causes
	Event	Action
4:262	Error when Ergo cabin tilted up.	Interrupted circuit in operator cabin output signal for upward tilt.
	Cabin tilt deactivated.	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal (K1:10) on the ACT.
4:263	Error on digital output signal 4.	Interrupted circuit in output signal for AUX 2.
	AUX deactivated.	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal (X131:21).
4:264	Error on digital output signal 12.	Interrupted circuit in output signal for AUX 3.
	AUX deactivated.	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal (X131:10).
4:265	Error on digital output signal 13.	Interrupted circuit in output signal for AUX 4.
	AUX deactivated	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal (X131:24).
4:266	Error on digital output signal 14.	Interrupted circuit in output signal for AUX 1.
	AUX deactivated	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal (X131:38).
4:267	Error when Ergo cabin tilted down.	Interrupted circuit in output signal for downward tilt of Ergo cabin.
	Cabin tilt deactivated.	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the signal (K1:2) on the ACH.
4:268	Error on digital output signal 11.	Interrupted circuit in output signal for AUX direction A.
	AUX deactivated.	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal (X131:37).
4:269	Error on digital output signal 15.	Interrupted circuit in output signal for AUX direction B.
	AUX deactivated.	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal (X131:11).
4:270	Error on MCU output signal 1.	Interrupted circuit in output signal for main lift valve.
	Lift deactivated.	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal (X131:26).
4:272	Error on MCU output signal 3.	Interrupted circuit in output signal for mast reach valve.
	Reach movement deactivated	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal (X131:41).

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Code	Name	Description/possible causes
	Event	Action
4:273	Error on MCU output signal 4.	Interrupted circuit in output signal for mast retraction valve.
	Reach movement deactivated	Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal (X131:13).
4:280	Analogue signal 1 error.	Lift/lowering lever voltage outside the permitted range 0.3–4.7 V.
	Lift/lowering deactivated.	Check the wiring harness in the control panel. Replace the lever. Check input signal X505:2.
4:281	Analogue signal 2 error.	Reach mast lever voltage outside the permitted range 0.3–4.7 V.
	Reach mast deactivated.	Check the wiring harness in the control panel. Replace the lever. Check input signal X505:11.
4:282	Analogue signal 3 error.	Aux 1 lever voltage outside the permitted range 0.3–4.7 V.
	Aux 1 lever deactivated.	Check the wiring harness in the control panel. Replace the lever. Check input signal X505:17.
4:283	Analogue signal 4 error.	Aux 2 lever voltage outside the permitted range 0.3–4.7 V.
	Aux 2 lever deactivated.	Check the wiring harness in the control panel. Replace the lever. Check input signal X505:3.
4:284	Analogue signal 5 error.	Aux 3 lever voltage outside the permitted range 0.3–4.7 V.
	Aux 3 lever deactivated.	Check the wiring harness in the control panel. Replace the lever. Check input signal X505:12.
4:285	Speed sensor error	Interrupted circuit/short circuit in the speed sensor.
	All hydraulic functions deactivated.	Check the wiring harness to sensor B11. Check sensor B11.
4:286	Fork tilt sensor error	The sensor signal is outside the permitted range, 0.3–4.7 V.
	All hydraulic functions deactivated.	Check the sensor and wiring harness to the sensor.
4:287	Sideshift sensor error	Both sensor signals are absent.
	All hydraulic functions deactivated.	Check the sensors and wiring harness to the sensors.
4:520	Start-up error	
4:561	Error on the free lowering valve.	Interrupted circuit in output signal for the free lowering valve.
		Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal (K1:2).

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Warning and error codes

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Code	Name	Description/possible causes
	Event	Action
4:571	Error on MCU output signal 2.	Interrupted circuit in output signal for the main lowering valve.
		Check the magnetic coil, electrical supply, contacts and wiring harness. Check the output signal (X131:40).
Group 5 Steering system warnings and errors		
5:010-5:011	CAN communication warning	The EPS CAN module has received/transmitted too many error messages.
		Check that CAN 2 is intact in terms of wiring harness, socket resistors and contacts.
5:035	Temperature warning	The EPS temperature exceeds 68 °C.
		Check the motor compartment fan.
5:135	I2T warning	EPS temperature has reached 80 % of the permitted value.
	Driving speed is reduced to 8 km/h.	The code is followed by 5:325 if the problem persists.
5:182-5:184	Reference sensor error	Reference sensor signal is incorrect.
	See 5:135.	Check the wiring harness X130:25.
5:3005:304	Error on steering	The steering does not react as it should when steering.
	Driving deactivated. The truck is braked with the motor brake until it stops.	
5:301	Power stage error	EPS has lost the power stage without transmitting an error message.
	See 5:300.	
5:302	Data download error	The MCU has not been able to download parameters to the EPS.
	See 5:300.	Download a new program to both the MCU and the EPS.
5:303	Start-up error	No response from the EPS on start-up.
	See 5:300.	Check the EPS wiring harness and fuse F64.
5:320	Incorrect DC voltage	EPS direct current is under 24 V.
	See 5:300.	Check the wiring harness, the fuse F72, and the main contactor.
5:325	I2T error	The EPS is limiting the current to the nominal value (10 A).
	See 5:300.	Check that the drive wheel has not got jammed in the floor. This problem can occur if the operator continues to steer when the truck has stopped or is stationary.
5:326	Temperature error	The temperature on the EPS power stage is outside the permitted range, -40 to +85 °C.
	See 5:300.	

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Code	Name	Description/possible causes
	Event	Action
5:335-5:336	Internal error	EPS internal error
5:380	Steer sensor, error	Power supply error, steer sensor 1 in the steering wheel.
	See 5:300.	Check the steer sensor and wiring harness.
5:381	Steer sensor, error	Power supply error, steer sensor 2 in the steering wheel.
	See 5:300.	Check the steer sensor and wiring harness.
5:382	Steer sensor, error	Abnormal speed from the steer sensor in the steering wheel.
	See 5:300.	Check the pulse generator and wiring harness.
5:383	Steer sensor, error	Steer sensor 1 and 2 in the steering wheel transmit different signals
	See 5:300.	Check the steer sensor and wiring harness.
5:414-5:416	CAN 2 communication error	The MCU or EPS has not received a response via CAN in 70 ms.
	The truck is braked with the motor brake until it stops.	Check that CAN 2 is intact in terms of wiring harness, final resistance and contacts.
5:421	Incorrect DC voltage	The EPS DC voltage exceeds 78 V.
	See 5:414.	Check the wiring harness and fuse F64.
5:422	Short circuit	
	See 5:414.	
5:435-5:438	Internal error	EPS internal error
5:500	Unexpected error	Unknown steering error.
		Check that the same versions of the software are being used in the MCU and EPS. Update to the latest version. Report to BT.
5:509	Unwanted steering movement	The steered wheel turns in spite of no steering command being transmitted.
Group 6 Does not apply to reach mast trucks.		
Group 7 GFU warnings and errors		
7:411-7:412	CAN communication error	The MCU or GFU have not received a response via CAN in 70 ms.
	The truck is braked with the motor brake until it stops.	Check that CAN 1 is intact in terms of wiring harness, final resistance and contacts.

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7.3 ACT/ACH transistor regulators

7.3.1 Cable connections and pole bolts

Connections, travel control (ACT)				
Connection	Cable	Designation	Active	In/Out
1	14	Motor temperature		In
2	35	Cabin tilt, down	0 V PWM	Out
3	-			
4	-			
5	-			
6	11	GND	0 V	Out
7	218	CAN2 - GND	0 V	In
8	219	CAN2 H	0–5 V	In/Out
9	27	Off/On	48 V	In
10	34	Cabin tilt, up	0 V PWM	Out
11	10	Sensor +	12 V, 50 mA	Out
12	-			
13	12	Pulse transducer, phase 1	12 V, 1 kOhm	In
14	13	Pulse transducer, phase 2	12 V, 1 kOhm	In
15	–			
16	220	CAN2 L	0–5 V	In/Out
B+	8	Battery +	48 V	In
B-	40	Battery -	0 V	In
U	2	Motor winding U	0–33 V	Out
V	3	Motor winding V	0–33 V	Out
W	4	Motor winding W	0–33 V	Out

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Connections, lift regulator (ACH)				
Connection	Cable	Designation	Active	In/Out
1	19	Motor temperature		In
2	35	Valve, lower initial mast	0 V PWM	Out
3	-			
4	-			
5	-			
6	16	GND	0 V	Out
7	218	CAN2 –	0 V	In
8	219	CAN2 H	0–5 V	In/Out
9	27	Off/On	48 V	In
10	36	Valve, lift initial mast	0 V PWM	Out
11	15	Sensor +	12 V, 50 mA	Out
12	16	Choice of ID	0 V	In
13	17	Pulse transducer, phase 1	12 V, 1 kOhm	In
14	18	Pulse transducer, phase 2	12 V, 1 kOhm	In
15	219	CAN2 H	0–5 V	In/Out
16	220	CAN L	0–5 V	In/Out
B+	8	Battery +	48 V	In
B-	40	Battery –	0 V	In
U	5	Motor winding U	0–33 V	Out
V	6	Motor winding V	0–33 V	Out
W	7	Motor winding W	0–33 V	Out

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7.3.2 Connections on the MCU

There are two 42-pin closed JPT contacts on the same side of the board.

Connections, MCU				
Connection	Cables	Designation	Active	In/Out
X130:1	55	Current source +5 V	5 V	Out
X130:3	69	Lift pressure	0.5–4.5 V	In
X130:4	85	Brake pedal, reference 1 (min.–max.)	0.5–4.5 V	In
X130:5	70	Voltage measurement, battery	48 V	In
X130:6	90	Earth, analogue	0 V	
X130:8	220	CAN2 low	0.5–2.5 V	In/Out
X130:10	81	Cabin tilt in upright position	48 V	In
X130:11	79	Reach carriage, sensor 2	48 V	In
X130:12	75	Height sensor - forks, upper free lift, pulse A ^{a)}	48 V	In
X130:13	131	Height sensor - forks, upper free lift, pulse B	48 V	In
X130:16	74	Fork tilt angle	0.5–4.5 V	In
X130:17	87	Accelerator	0.5–4.5 V	In
X130:18	86	Brake pedal, reference 2 (min.–max.)	4.5–0.5 V	In
X130:19	71	Battery measurement 2	0 V	In
X130:20	30	Earth, digital	0 V	Out
X130:22	219	CAN2 high	4.5–2.5 V	In/Out
X130:23	117	Current measurement +15 V, service key	15 V	Out
X130:24	80	Cabin tilt in lowered position	48 V	In
X130:25	57	Steered wheel 180°	48 V	In
X130:26	76	Height sensor - forks, upper free lift, pulse B	48 V	In
X130:27	139	Height reference - forks below free lift	48 V	In
X130:29	56	Earth, analogue	0 V	
X130:30	125	Input signal, pressure sensor, mast		
X130:31	84	Safety pedal	48 V	In
X130:32	72	Battery measurement 1	0 V	In
X130:33	218	CAN2 earth	0 V	Out
X130:34	118	Earth, service key	0 V	
X130:37	29	Current source +15 V	15 V	Out
X130:38	78	Reach carriage - sensor 1	48 V	In
X130:39	73	Height reference - forks below free lift	48 V	In
X130:40	130	Height sensor - forks, upper free lift, pulse A	48 V	In

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Connections, MCU				
Connection	Cables	Designation	Active	In/ Out
X130:41	83	Seat switch	48 V	In
X131:1	22	Current source	48 V	In
X131:2	141	Height reference – forks ^{b)}	48 V	In
X131:5	21	Status, emergency switch off		In
X131:6	28	Status, key relay	48 V	In
X131:7	31	Main relay	48 V	Out
X131:8	121	Turn signal lights, left	48 V	Out
X131:9	33	Fan control	0–48 V	Out
X131:10	67	Valve for AUX. 3	0–48 V	Out
X131:11	63	Valve for fork tilt/fork reach/AUX.	0–48 V	Out
X131:12	97	Brake, right-hand support arm	0–48 V PWM	Out
X131:13	60	Valve for reach carriage	0–24 V PWM	Out
X131:14	40	Earth	0 V	
X131:15	23	Charging capacitor	48 V	In/Out
X131:18	111	Fork reach sensor, left-hand side	48 V	In
X131:19	124	Login, special	48 V	In
X131:20	95	Parking brake	48 V	Out
X131:21	65	Valve for forkspread/AUX. 2	0–48 V	Out
X131:24	68	Valve for AUX. 4	0–48 V	Out
X131:25	88	Horn	48 V	Out
X131:26	59	Valve for main mast lift	0-24 V PWM	Out
X131:27	119	CAN1 high	4.5-2.5 V	In/Out
X131:32	112	Fork reach sensor, right-hand side	112	In
X131:34	34	Fan, chassis	0–48 V	Out
X131:35	122	Turn signal lights, right	48 V	Out
X131:36	98	Warning lamp	48 V	Out
X131:37	62	Valve for reach carriage	0–48 V	Out
X131:38	66	Valve for fork tilt/fork reach/AUX. 1	0–48 V	Out
X131:39	96	Brake, left-hand support arm	0–48 V PWM	Out
X131:40	58	Valve for main mast lowering	0–24 V PWM	Out
X131:41	61	Reach valve	0–24 V PWM	Out
X131:42	120	CAN1 low	0,5–2,5 V	In/Out

a. "Mast near to lowered position" when height measurement is not used.

b. "Forks near top of mast" when height measurement is not used.

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Symptom tables

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7.4 Symptom tables

7.4.1 Brake

Error	Cause	Action
Brake does not release	Voltage too low.	Check the truck battery. Charge if necessary.
	Interruption to voltage.	Check wiring harness to the brake. Restart the truck.
	Too much play.	Adjust the play.
	Worn friction disc.	Replace the friction disc.
	Coil defective.	Replace the brake.
	Too little play.	Adjust the play.
Brake does not brake	Voltage remains when truck is switched off.	Check the truck battery and its connections.
	Grease on the friction surfaces	Replace the friction disc and readjust the play.
Uneven braking effect	Voltage too low.	Check the truck battery. Charge if necessary.

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7.4.2 Telescopic forks

Error	Cause	Action
The forks run in and out unevenly	The hydraulic hoses are incorrectly connected	Connect the hydraulic hoses
	The four hoses are not the same length	
	Dirt between inner and outer forks	Remove the dirt
	Leakage at the piston seal	Replace the piston seal
	The distribution valve is damaged	Replace the distribution valve
The forks move with-out the levers being operated	Leak in the regulator valve	Check as below
The forks are leaking oil	Couplings are leaking	Correct fitting or replace couplings
	The cylinder head seal is damaged	Replace the cylinder head seal
	The fork is worn	Immediately remove the forks from the truck
The forks shake during extension and retraction	The regulator valve/pump is worn Insufficient flow	Check as below
One of the outer forks does not retract	The bolt is broken or loose	Replace or tighten the bolt with Loctite 542
The fork tips are no longer at the same height	One of the forks has been overloaded and has become permanently deformed	Remove the forks from the truck Check as below
Too great a tolerance between the inner and outer fork	The outer forks are worn or have been overloaded, resulting in the underside of the outer forks becoming permanently deformed	Replace the outer forks

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Symptom tables

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8 – Frame/Chassis 0000

8.1 General

The truck chassis consists of a base plate with support arms. The battery compartment and motor and cabin fixing points are then fitted to the chassis. The lifting mast and moving reach mast are not part of the chassis.

8.2 Motor hood (0340)

8.2.1 Opening the motor compartment

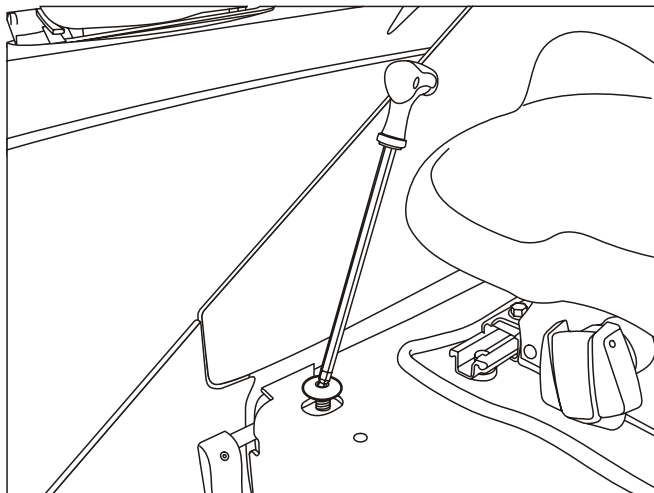
RRE 160-RRE 250

To open the motor compartment:

- Pull out the seat to its forward position.
- Loosen the screw (8 mm allen screw) beside the operator seat and swing the door out.

To close the motor compartment:

- Close the door by swinging it in and tighten the screw.



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8.3 Operator cabin (0500)

Cabin tilting RRE 160-250 Ergo

Make sure there is sufficient room for the tilted cabin before you start servicing work. Also make sure there is no risk of the cab accidentally being tilted back during servicing.



DANGER!

Risk of tipping.

The truck can tip if the battery is removed when the truck is tilted to the service position.

Never remove the battery from the truck.

On trucks with low lift heights – extend the mast so that the finger guards and panel are made accessible when tilting up. Check also that the cabin does not catch the mast, hose reel or other parts on the truck.

When you carry out servicing in the motor compartment you should tilt the cabin all the way up and over into its service position. This tilting process is only possible with the service key connected and the truck in service mode.

To tilt the cabin to its service position:

1. Insert the service key and put the truck into service mode.
2. Select the cabin tilt position.
3. Move the lever for fork lift backwards. Nobody should be sitting in the truck when the cabin is being tilted up.
4. Once the cabin's centre of gravity passes its centre of rotation (at approximately 45°), the cabin drops slowly into its service position.



DANGER!

Cabin dropping!

The cabin drops slowly when tilted beyond 45°.

Ensure nobody/nothing is next to the cabin when tilting.

To tilt the cabin to its normal position:

Ensure nobody is present in the motor compartment when tilting the cabin back.



DANGER!

Risk of crushing.

There is a very high risk of injury if anyone is present in the motor compartment when tilting the cabin back.

Ensure nobody is present in the motor compartment when tilting.

1. Shift the fork lift hydraulic lever forwards until the cabin stops in its normal position.

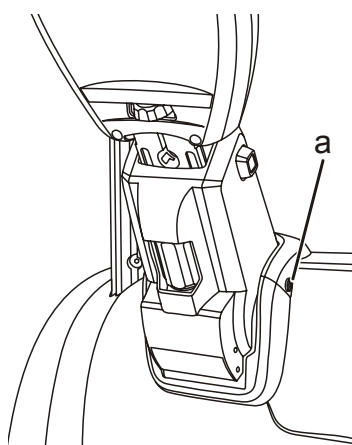
8.4 Operator compartment (0600)

8.4.1 Internal fittings (0680)

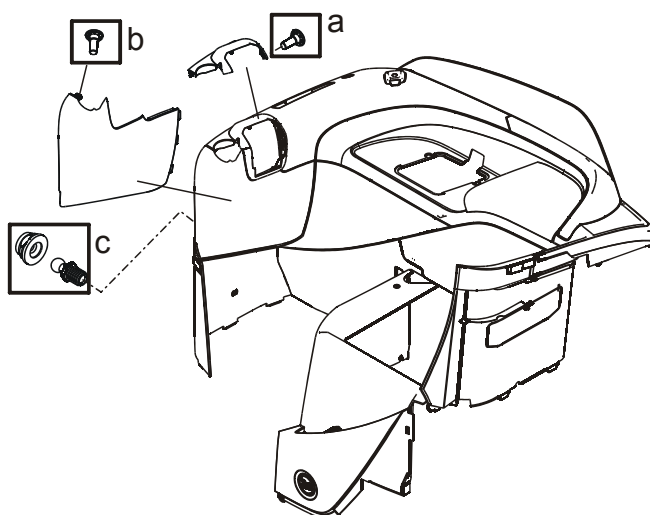
The interior of the operator compartment consists of interconnected panels that are tightly locked together, as well as with the cabin chassis.

Most of the panels are held in place without the use of screws or snap fasteners, but to remove the panels they must be dealt with in sequence.

1. Remove screw 'a' on the right of the tiller arm and remove the panel.



2. For the next panel, remove screw 'b' located in front of the tiller arm. This panel is also fixed in place with a snap fastener (c). Remove the entire panel.

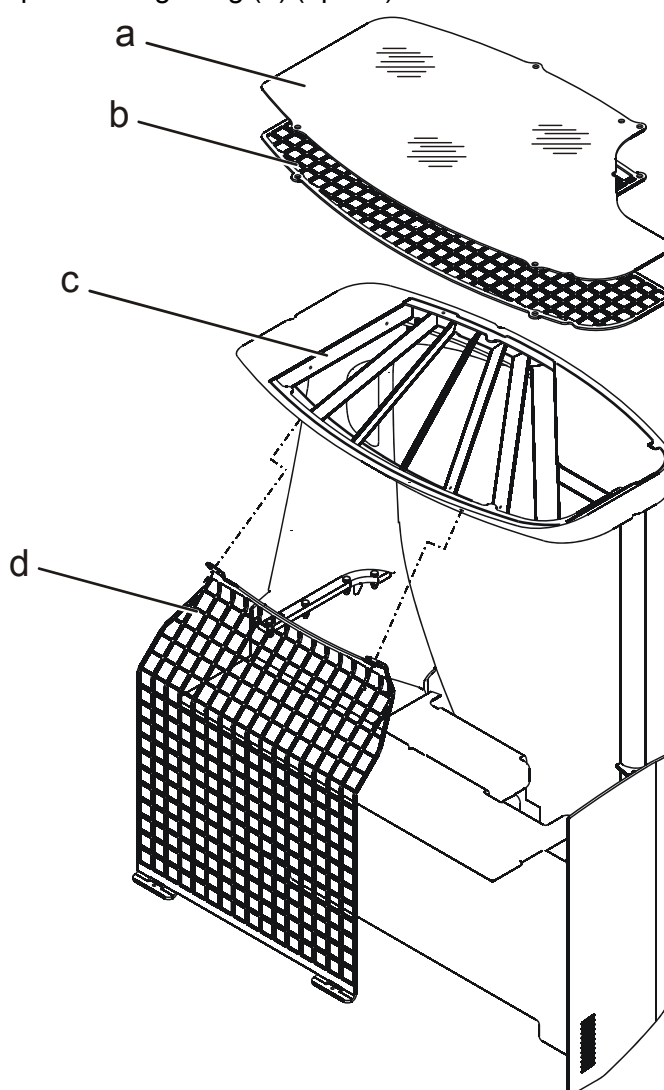


3. The remaining panels can now be removed one by one in sequence, without the use of tools.
4. Refit in reverse order.

8.5 Safety equipment (0800)

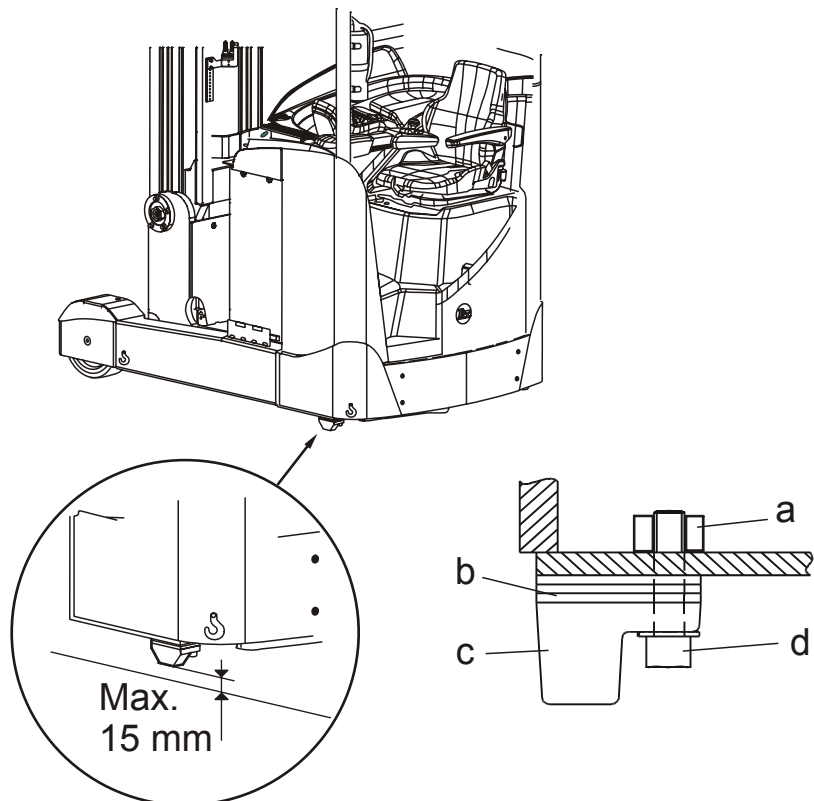
8.5.1 Checking the overhead guard (0810)

1. Prepare the truck for servicing.
2. Check the following for cracks and secure mounting:
 - The casing (c)
 - The finer mesh guard (b) (option)
 - The transparent top (a) (option)
 - The protective grating (d) (option).



8.5.2 Adjusting the tilt stops (0840)

1. Park the truck on a level surface.
2. Measure the distance between the tilt stop and the floor (max. 15 mm).
3. If the distance between the tilt stop and the floor is greater than this, the distance of the stops must be adjusted.
4. Lift up the rear edge of the truck using a jack and place a wooden block under the support arms to prevent the truck from tipping over.
5. Remove the screws (d), tilt stop (c) and shims (b).
6. Re-shim the stop so that the distance between it and the floor is as close to 15 mm as possible. The distance may not exceed 15 mm.
7. Refit in reverse order.



Frame/Chassis 0000

Safety equipment (0800)

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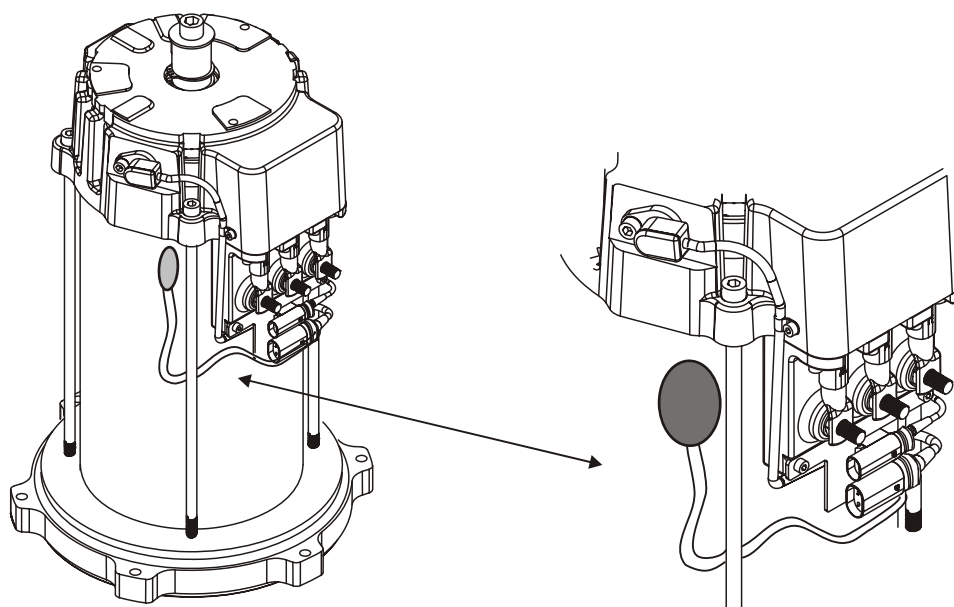
9 – Motors 1000

9.1 Motor sensors

9.1.1 Temperature sensor

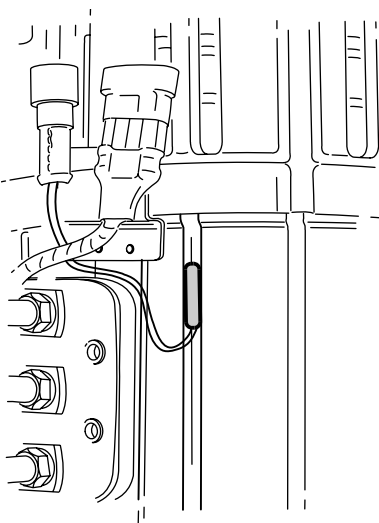
A working temperature sensor mounted inside the motor should give a resistance reading of approximately 550 ohms at 20 °C.

The temperature sensor mounted on the outside gives a resistance reading of approximately 670 ohms at 20 °C.



Retrofitting of external temperature sensor

1. The temperature sensor can be mounted to the right or left of the terminal block, depending on which side is easiest to access and the length of the cable from the new sensor.
2. Scrape the surface clean where the new temperature sensor is to be mounted.
3. Place the temperature sensor as shown in the illustration.



Motors 1000

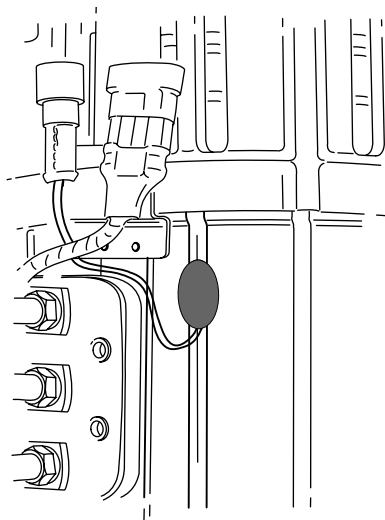
Motor sensors

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815, 816

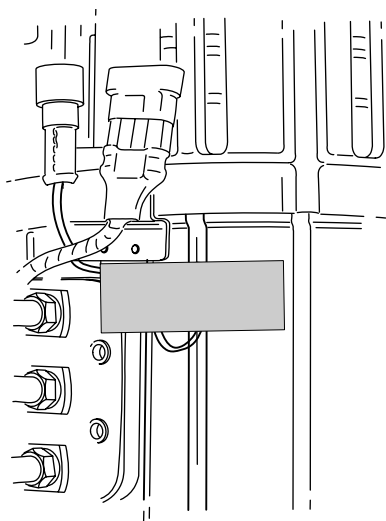
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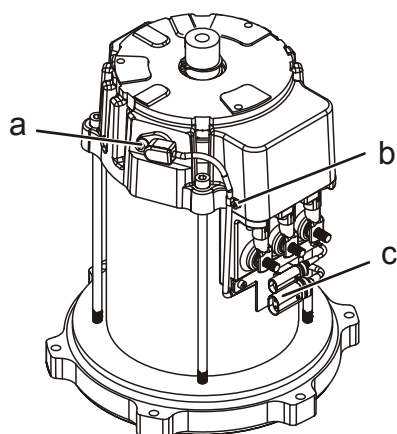


4. Apply plastic padding over the sensor. Ensure that the entire sensor is covered by the plastic padding.



5. Fix the plastic padding and the sensor in place with masking tape and allow it to harden.
6. Remove the masking tape. The temperature sensor should now be fixed in place and covered entirely by the plastic padding.
7. Remove the ferrite block from the old sensor and mount it on the cable to the new sensor.
8. Remove the contact from the broken sensor, which is attached to the motor.
9. Place the new sensor contact in the old bracket and connect it to the harness.
10. Fasten the old contact and its harness using a cable tie so it cannot damage anything.

9.1.2 Replacing the motor speed sensor



1. Remove the screw (a) (5 mm allen screw) and withdraw the sensor.
2. Loosen the cable clamp (b) (3 mm allen screw).
3. Loosen the cable connection of the sensor (c) from the motor by pushing in the locking pin on the rear of the contact.
4. Reassemble in reverse order. Tightening torque 6 Nm.

9.2 Pump motor (1710)

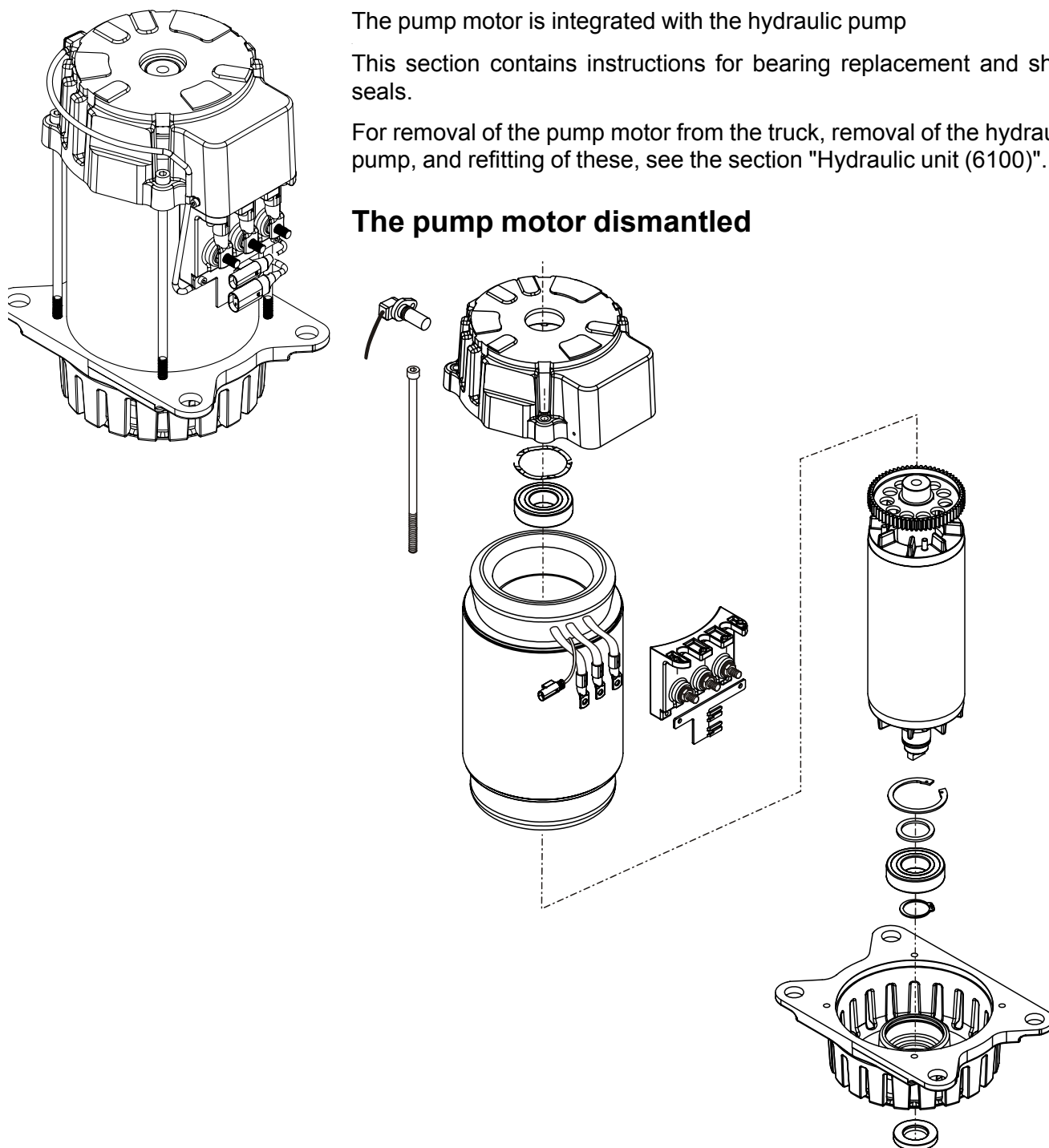
9.2.1 General

The pump motor is integrated with the hydraulic pump

This section contains instructions for bearing replacement and shaft seals.

For removal of the pump motor from the truck, removal of the hydraulic pump, and refitting of these, see the section "Hydraulic unit (6100)".

The pump motor dismantled

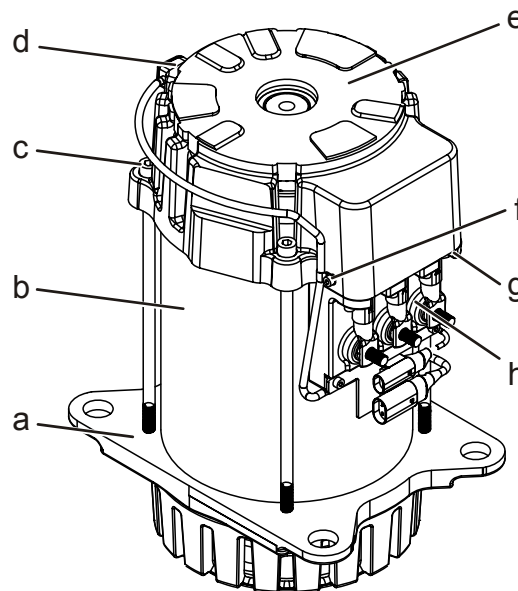


9.2.2 Replacing the bearing on the pump motor

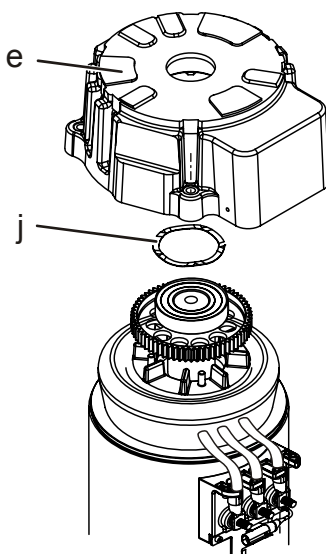
Dismantling the pump motor

Motor without pump.

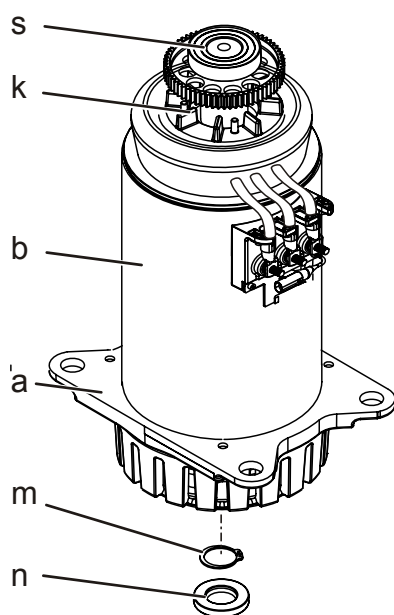
1. On the stator (b) and the N- (e) and D-shield (drive end) (a), mark how these are located in relation to each other.
2. Unscrew the four screws (g) that hold the power terminal block (h) in the N-shield.
3. Remove the four long screws (c) (6 mm allen screws).
4. Remove the pulse transducer (d) (5 mm allen screw) from the N-shield and loosen the cable clamp (f) (3 mm allen screw)



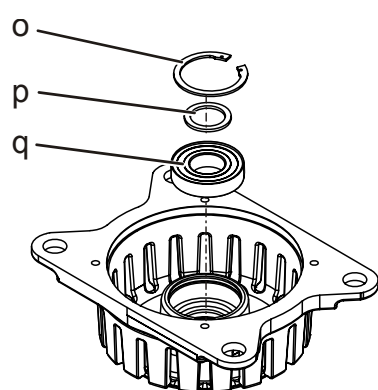
5. Lift out the N-shield (e) and spring washer (j).



6. Remove the seal (n) and locking ring (m) from the rotor shaft.
7. Lift the rotor (k) out of the stator (b).
8. Remove the D-shield (a) from the stator.

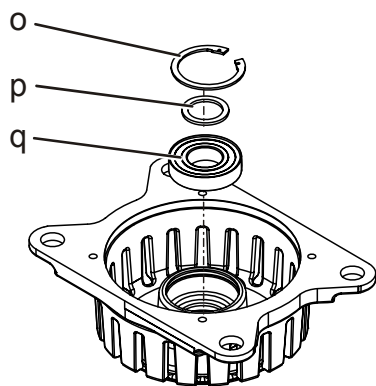


9. Remove the locking ring (o) and support ring (p).
10. Remove the bearings (s, q) from the rotor and the D-shield with a puller.



Assembling the pump motor

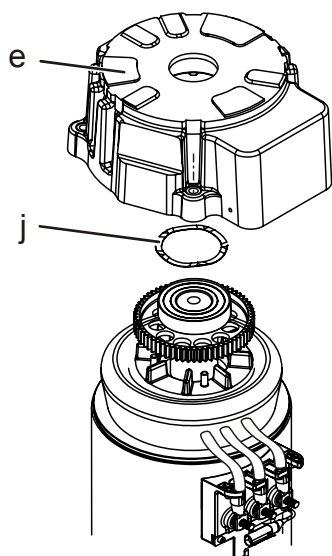
Ensure all parts are intact and clean before assembly.



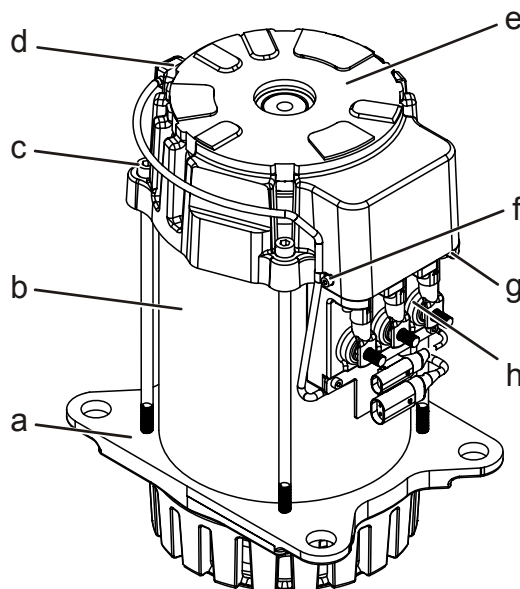
1. Place a bearing (q) in the D-shield (a).
2. Place the support ring (p) and locking ring (o) in the D-shield (a).
3. Place the stator (b) in the D-shield in line with the markings made during dismantling.
4. Push the bearing (s) onto the rotor shaft.
5. Place the rotor in the D-shield.
6. Place the locking ring (m) on the rotor shaft.
7. Place the seal (n) using the assembly device.

IMPORTANT

Always use a new seal when fitting the rotor shaft.



8. Place the spring washer (j) and N-shield (e).
9. Secure the four screws (g) that hold the power terminal block (h) in the N-shield.
10. Place the four long screws (c) - tightening torque 15 Nm.
11. Place the pulse transducer (d) in the N-shield and attach the cable clamp (f).



12. Attach the pulse transducer's connector unit in the bracket under the power terminal block.

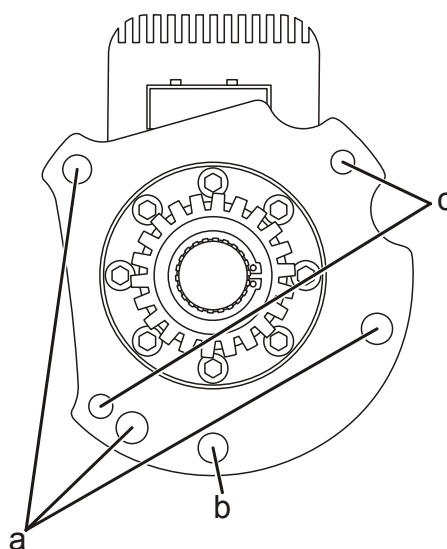
9.3 Steering motor and steering unit (1730)

9.3.1 General

The steering motor can turn the drive unit through 360°.

This section contains instructions for steering motor replacement.

9.3.2 Layout of the flange holes



View from the steering motor underside.

a: Mounting,

b: Steering,

c: Threaded M10 holes

Motors 1000

Steering motor and steering unit (1730)

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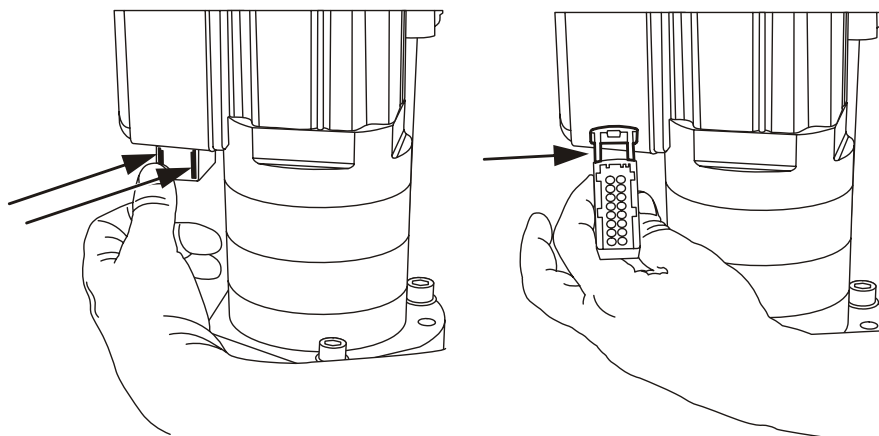
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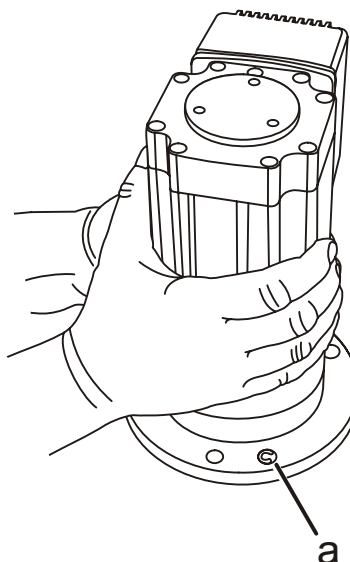
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9.3.3 Removing the steering motor from the truck

1. Prepare the truck for servicing and open the motor compartment.
2. Disconnect the connector unit from the steering motor. The connector unit is locked with a catch (arrow) that must be pressed out before the connector unit can be undone.



3. Remove the three mounting screws (8 mm allen screws) of the steering motor.
4. Remove the motor. The motor bracket has a guide pin (a) that can jam when removing the motor. Use M10 screws as a puller in the threaded holes if the motor gets jammed.



9.3.4 Placing the steering motor in the truck

1. Clean the guide pin hole in the motor bracket and place the motor. Tightening torque 45 Nm.
2. Connect the connector unit for the steering motor and press the locking catch in.

9.4 Fan motor/fan (1740)

9.4.1 General

There are two fans in the truck's motor compartment. One fan cools the motors' frequency converter and the other ventilates the entire motor compartment.

This section contains instructions for fan replacement.

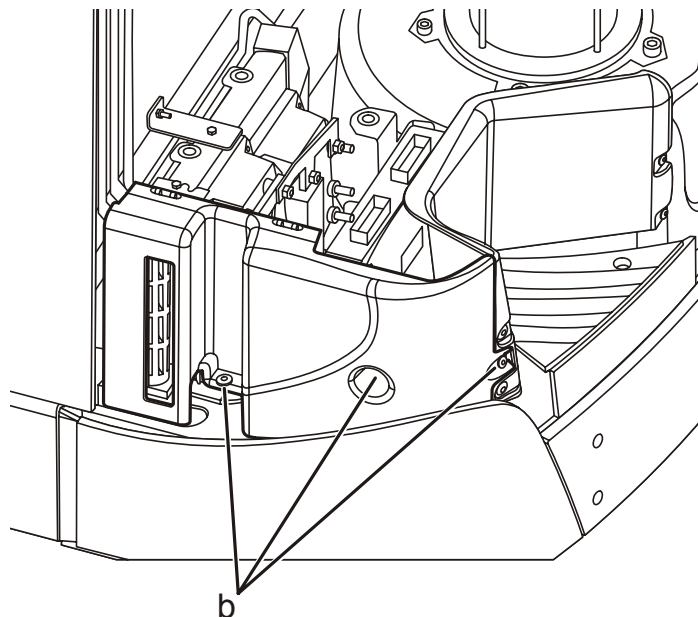
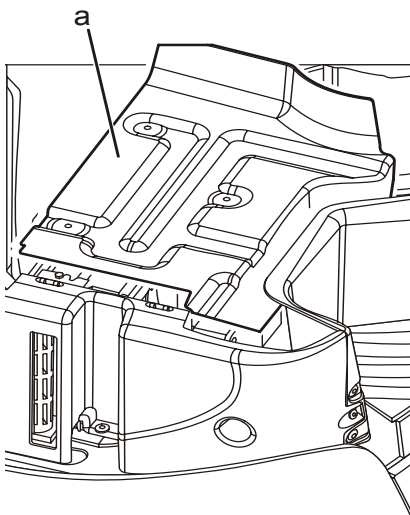
9.4.2 Replacing the frequency converter cooling fan

Standard truck

1. Prepare the truck for servicing and open the motor compartment.
2. Remove the step and floor with the pedals - see the section "Replacing the drive gear".

Ergotruck

1. Remove the covers that cover the MCU and the traction and lift transistor regulators.
2. The top cover (a) can be lifted off without any tools (snap fastener).
3. The cover at the fan exhaust is screwed on with three screws (b) (12 mm allen screws).



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Fan motor/fan (1740)

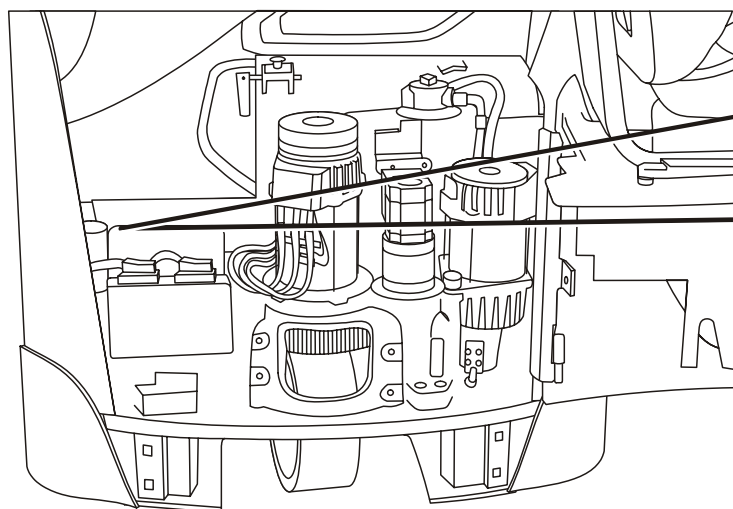
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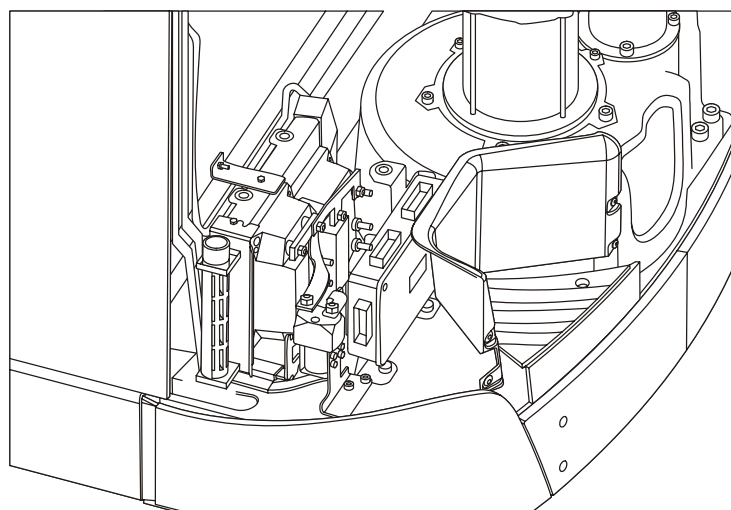
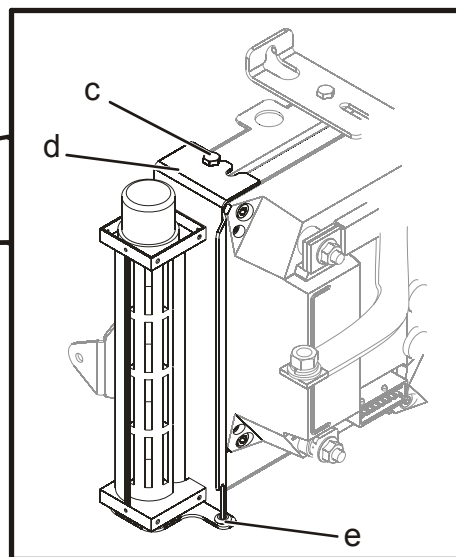
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4. Disconnect the cooling fan harness.
5. Remove the screw (c) (10 mm hex screw) that holds the cooling fan's mounting bracket.
6. Remove the cooling fan (d).
7. Place the new cooling fan. Ensure the two pins in the cooling fan's mounting bracket engage in the vibration dampers (e) in the cooling block.



Standard model

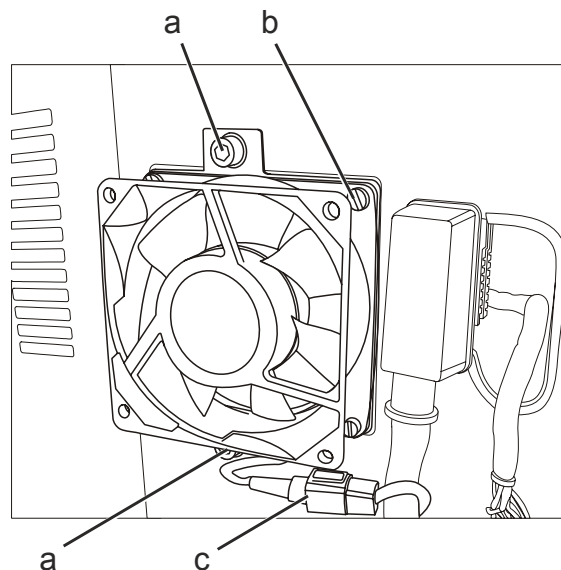


Ergo model

8. Screw the cooling fan in place.
9. Connect the harness.
10. Refit any covers or the floor.

9.4.3 Replacing the motor compartment cooling fan

1. Prepare the truck for servicing and open the motor compartment.
2. Disconnect the cooling fan harness (c).
3. Remove the screws (a) (6 mm allen screws) that hold the cooling fan and air duct in place.
4. Remove the cooling fan from the air duct - 4 slot-head screws (b).
5. Place the new cooling fan.
6. Screw the cooling fan in place.
7. Connect the harness.

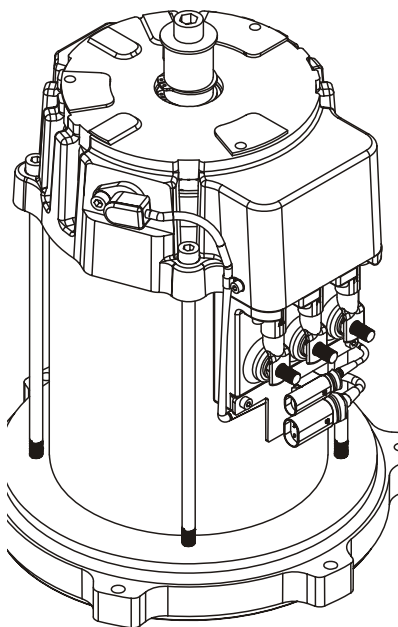


9.5 Drive motor (1760)

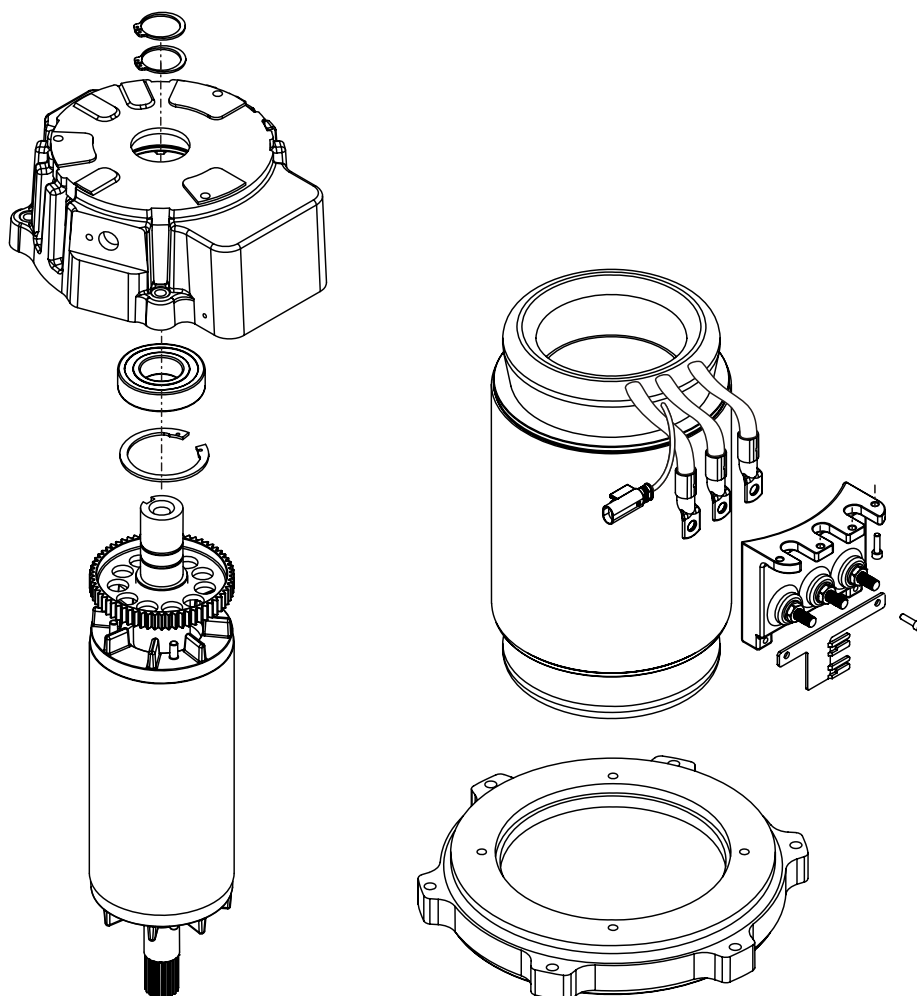
9.5.1 General

The drive motor is integrated with the drive gear to form a complete drive unit that can be steered through 360°.

This section contains instructions for drive motor replacement, dismantling/assembly of the drive motor, and bearing replacement.



The drive motor dismantled

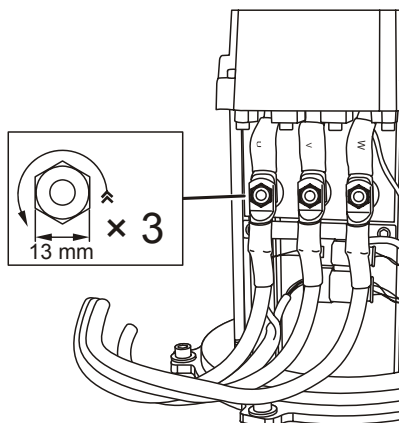


9.5.2 Removing the drive motor from the truck

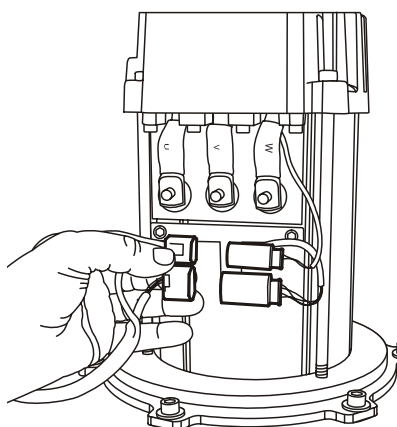
Tools

Lifting eye V11-1258 (M12x20 mm)

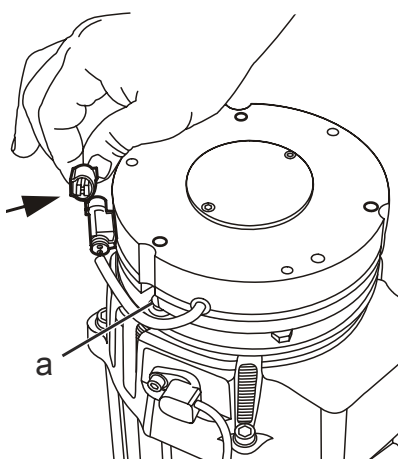
1. Prepare the truck for servicing and open the motor compartment.
2. Disconnect the power cables from the drive motor.



3. Undo the connector unit for the temperature sensor and pulse transducer.



4. Undo the brake cable connector unit.



Motors 1000

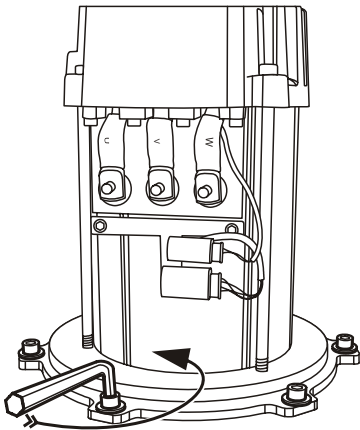
Drive motor (1760)

T-code
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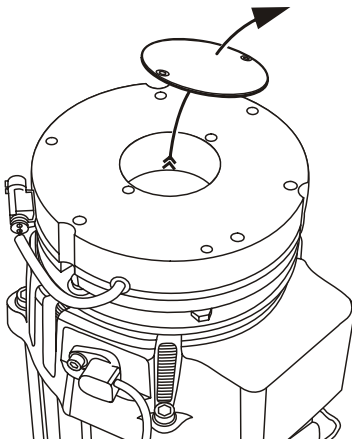
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5. Remove the six screws (6 mm allen screws) that hold the drive motor in place.



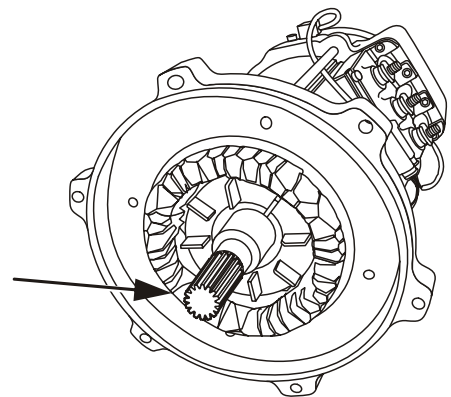
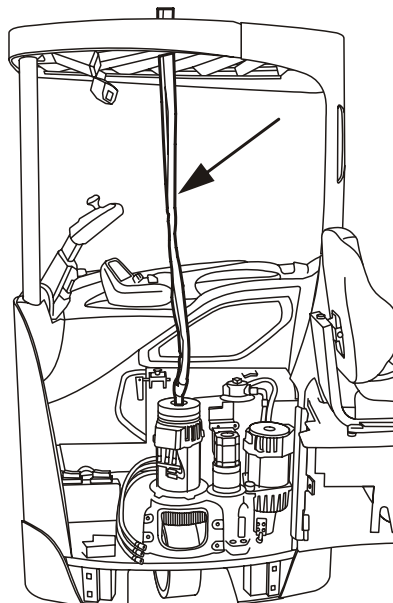
6. Remove the cap at the centre of the parking brake (2.5 mm allen screws).
7. Attach the lifting eye V11-1258 (M12x20 mm) to the drive motor shaft.
8. Carefully lift the motor straight up; paying attention to the splines on the output shaft of the motor. The motor weighs approximately 40 kg.

IMPORTANT!

Risk of spline damage.

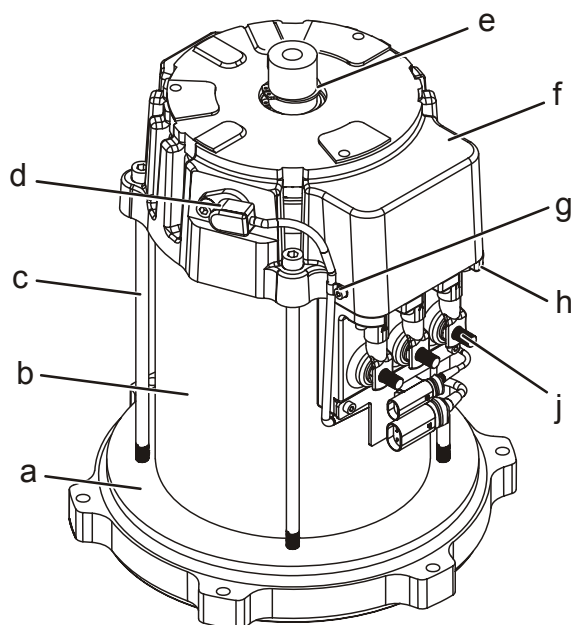
The splines on the end of the motor are easily damaged.

Be careful when lifting out the motor.

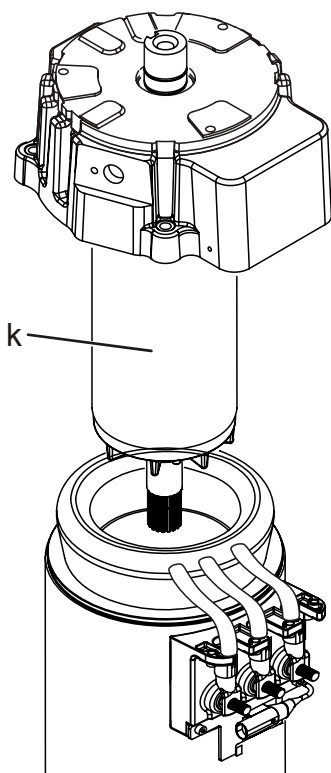


9.5.3 Dismantling the drive motor

1. Remove the parking brake - see the section "Removing the parking brake from the truck".
2. On the stator (b) and the N- (e) and D-shield (drive end) (a), mark how these are located in relation to each other.
3. Remove the pulse transducer (d) and loosen the cable clamp (g).
4. Unscrew the four screws (h) that hold the power terminal block (j) in the N-shield.
5. Remove the two locking rings (e) from the motor shaft.
6. Remove the long screws (c).



7. Lift the N-shield and the rotor (k) from the stator.



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Drive motor (1760)

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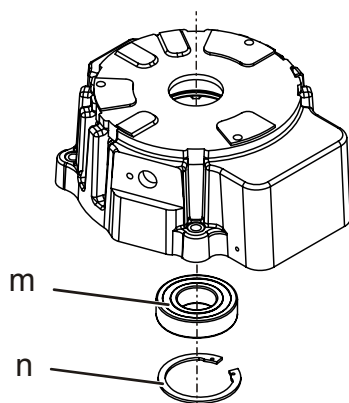
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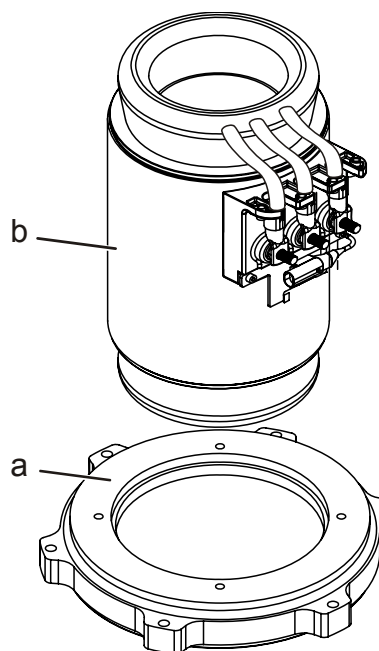
8. Pull the N-shield off the rotor with a standard puller.

9. Remove the locking ring (m).

10. Push the ball bearing (n) out of the N-shield.



11. Use a light blow to carefully remove the drive-end shield (a) from the stator (b).



9.5.4 Cleaning

The motor should be cleaned dry, preferably by vacuuming it. Do not wash the motor in water.

The insulation resistance on a cleaned and dry motor should be in excess of 1 G ohm under cool conditions.

9.5.5 Assembling the drive motor

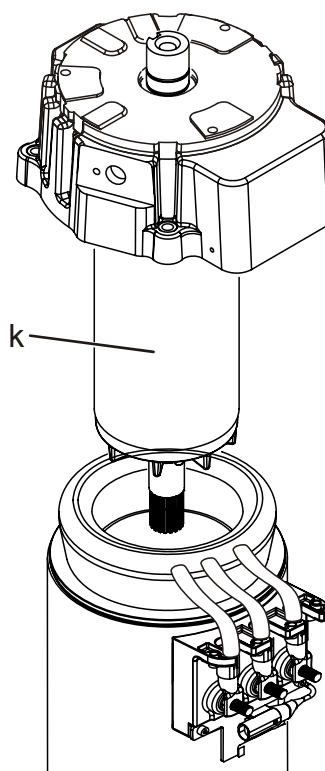
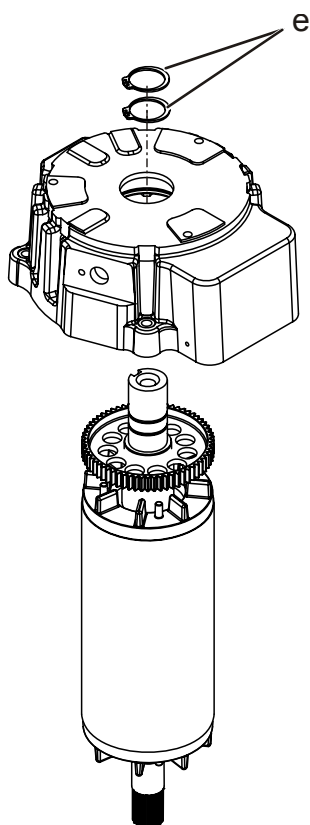
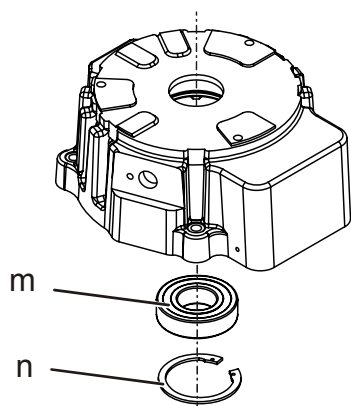
Ensure all parts are intact and clean before assembly.

1. Using standard tools, insert a new ball bearing (m) in the N-shield.
2. Place the locking ring (n).
3. Position the D-shield (a) against the stator in line with the markings (b).

IMPORTANT!

If the original parts are being used, the stator (b) and the D-shield (drive end) (a) should have their relative mounting positions clearly marked, as in the illustration.

4. Insert the rotor shaft in the bearing and place the locking rings (e) on the rotor shaft.
5. Insert the rotor (k) with the N-shield in the stator.



Motors 1000

Drive motor (1760)

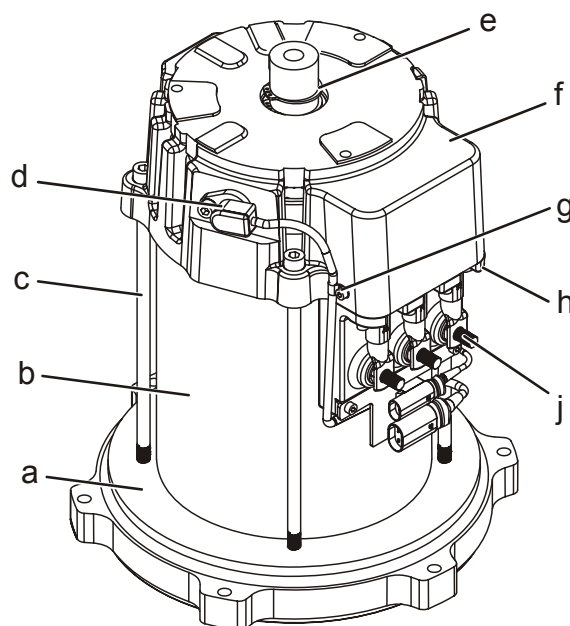
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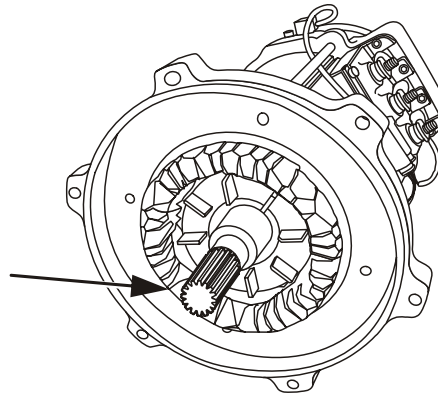
6. Insert the screws of the power terminal block (h) and tighten.
7. Insert and tighten the long screws (c) – tightening torque 15 Nm.
8. Refit the speed sensor (d) along with its harness (g).
9. Replace the contact in the holder under the power cables.
10. Fit the parking brake - see the section "Fitting the parking brake to the truck".



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9.5.6 Fitting the drive motor to the truck

1. Lubricate the splines on the output shaft of the motor with Klüberplex BEM34-132 (226158).
2. Attach a lifting eye to the shaft end of the motor and lift the motor into place in the truck, paying attention to the splines on the shaft end.
3. Turn the motor shaft if its output shaft does not fit into the drive gear input shaft.



4. Tighten the motor. Tightening torque 25 +4/-2 Nm.
5. Connect the power cables of the motor – tightening torque 20 Nm.
6. Connect up the connector unit for the sensor and brake.
7. Place the cap in the centre of the parking brake (2.5 mm allen screws).

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Drive motor (1760)

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10 – Drive gear 2000

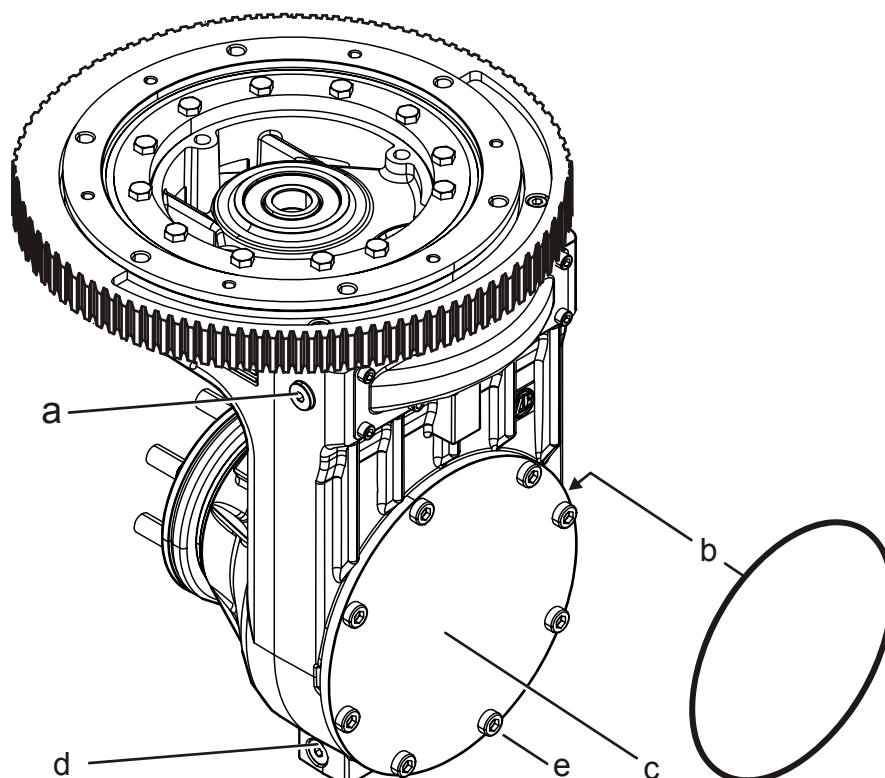
10.1 General

The drive gear is integrated with the drive motor and brake to form a complete drive unit which can be steered through 360°.

This chapter contains instructions for drive gear replacement. A complete renovation of the drive gear is so extensive that it must be done in the workshop by specially trained personnel.

10.1.1 Leakage from the bottom cap

1. Prepare the truck for servicing.
2. Drain the remaining oil from the gear.
3. Remove the cap (c) from the gear.
4. Replace the seal on the drain plug (d) and the O-ring (b) on the cap.
5. Place the cap and tighten the bolts to a torque of 46 Nm. Make sure the O-ring does not become damaged. The bolts should be oiled before being fitted.
6. Fill the gearbox up with new oil as far as the upper oil level plug (a).
7. Change the seal on the oil level plug (a) and fit it.



10.1.2 Replacing the drive gear

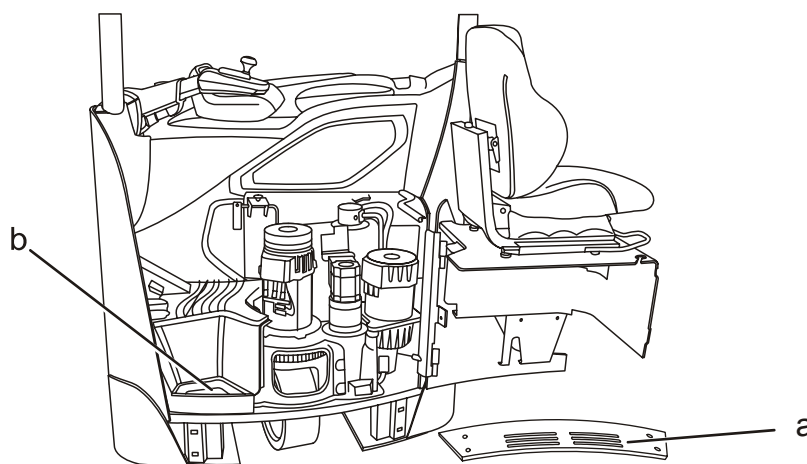
Special tools

Lifting eye for motor

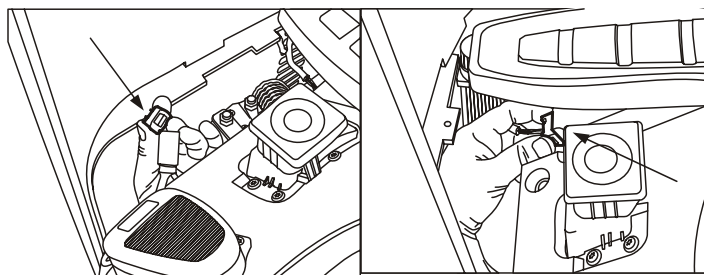
3 screws, M12x110 mm

Exposing the drive gear

1. Prepare the truck for servicing.
2. Remove the fender (a) and the step plate (b).



3. Remove the fixing screw (arrow) for the floor and pedals.
4. Undo the connector units for the pedal harness (press the lugs of the female contact together to undo the contact).
5. Remove the floor and pedals.



Removing a drive motor from the truck

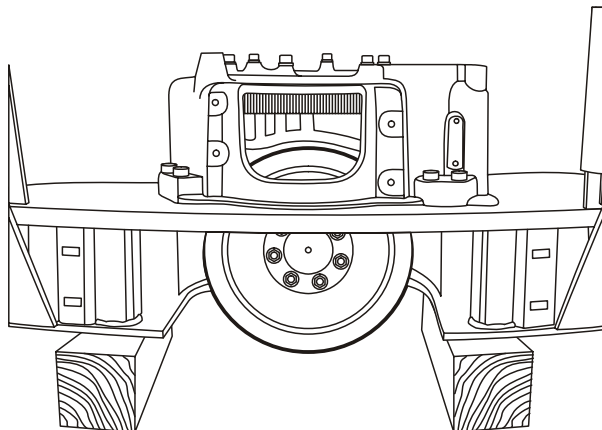
See the section "Removing the drive motor from the truck".

Removing a steering motor from the truck

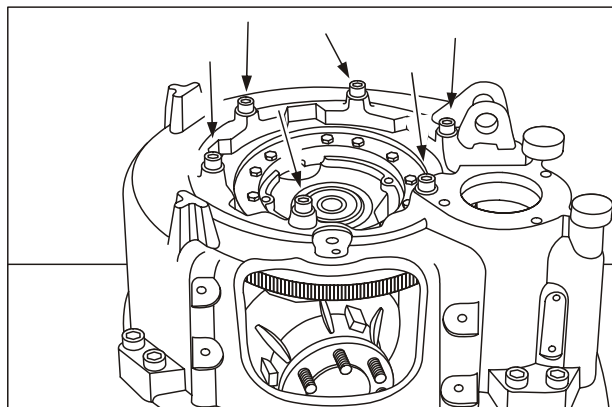
See the section "Removing the steering motor from the truck".

Removing the drive gear from the truck

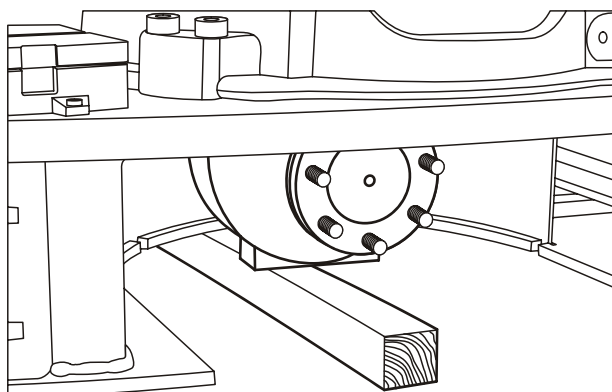
1. Undo the locking nuts on the drive wheel..



2. Use a jack to raise the truck by approximately 16 cm.
3. Chock the truck up.
4. Remove the drive wheel. See the section "Drive wheel, replacement (3530)".
5. Undo the six gear screws.



6. Place a block of wood, approximately 70×70 mm, under the gear.
7. Lower the truck so that the gear is resting on the block of wood.

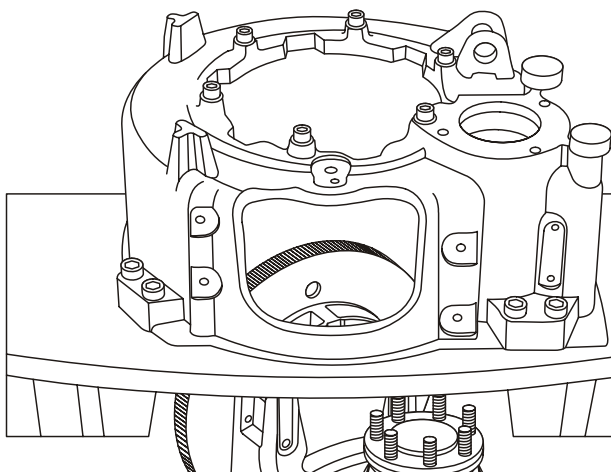


Drive gear 2000

General

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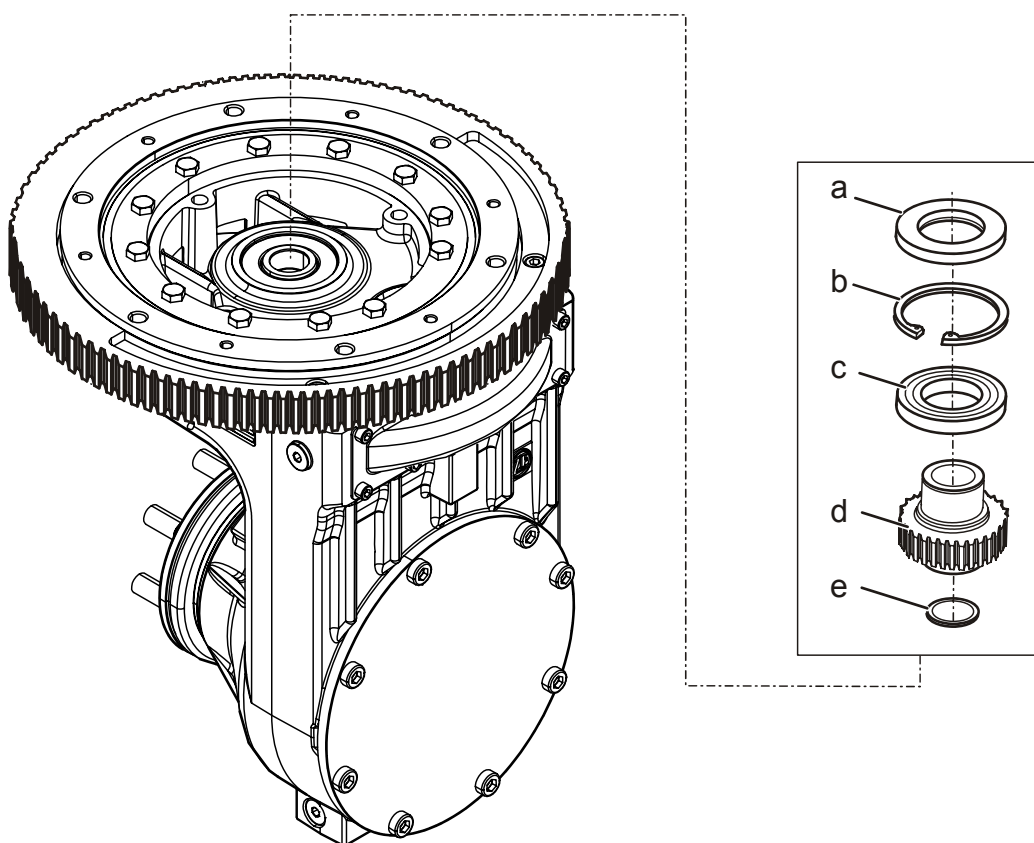
8. Remove the screws holding the gear.
9. Raise the truck by 21 cm and chock up the truck.
10. Lower the gear onto the floor.
11. Extract the gear in a lying down position. The gear weighs approximately 60 kg.



10.1.3 Replacing the pinion gear, input shaft

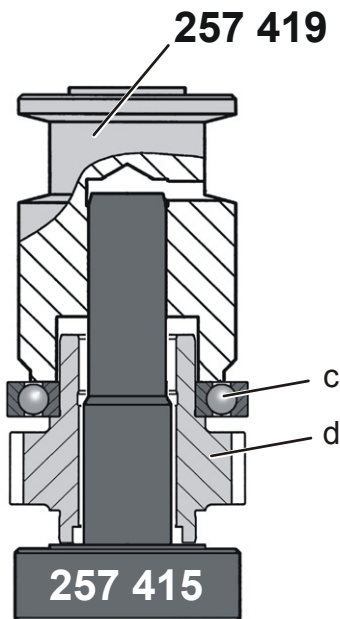
Remove the pinion gear

1. Use a screwdriver to remove the seal (a). Be careful with the surface of the seal on its drive gear side.
2. Remove the locking ring (b).
3. Extract the pinion gear (d) from the gear housing using tool 257421.
 - Tighten the nut on the puller. The nut opens out the claws of the puller.
 - Give a few powerful upward pulls on the handle of the puller to loosen the pinion gear.
 - Carefully lift out the pinion gear (d) to avoid damaging the teeth.
 - Loosen the nut on the puller to release the pinion gear.
4. Pull the bearing (c) off the pinion gear with a claw puller.



- a. Seal
- b. Locking ring
- c. Bearing
- d. Pinion gear
- e. Sealing ring

Placing a new ball bearing



Use fixture 257415 and push-on sleeve 257419 to fit the bearing on the pinion gear.

1. Place the pinion gear on the guide of fixture 257415 and exert pressure on the latter until contact is made.
2. Place the pinion gear (d) on fixture 257415.
3. Fit the ball bearing (c) and press-on sleeve 257419.
4. Exert pressure on the ball bearing until it makes contact with the pinion gear (d).

If no press is available, the bearing can be fitted in the following way instead:

DANGER!

Risk of injury from burns! Use protective gloves.

Heat the ball bearing to a maximum of 90 °C and fit the bearing so that it makes contact with the pinion gear.

Fit the pinion gear once the bearing has cooled down.

Fitting the sealing ring

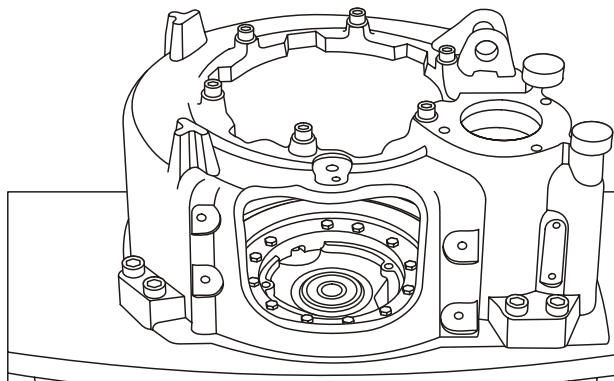
1. To seal the gear wheel against the gear housing a sealing ring (e) must be fitted. Before fitting the seal, use LOCTITE® 5910 on the surfaces that come into contact with each other.
2. Use a press to push the seal in until it makes contact.

Inserting the pinion gear in the drive gear

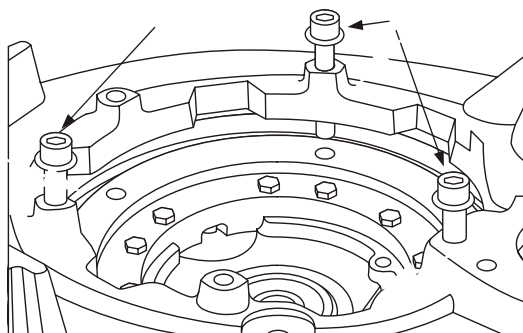
1. Carefully insert the pinion gear in the gear housing. To get it into position you may need to rotate the wheel axle.
2. Use tool 257412 to press the pinion gear into the gear housing until it makes contact.
3. Fit the locking ring above the pinion gear.
4. Apply grease sparingly to the seal. Apply LOCTITE® 574 to the outer edge of the seal.
5. Use tool 257414 to push the seal in until it makes contact.

10.1.4 Placing the drive gear in the truck

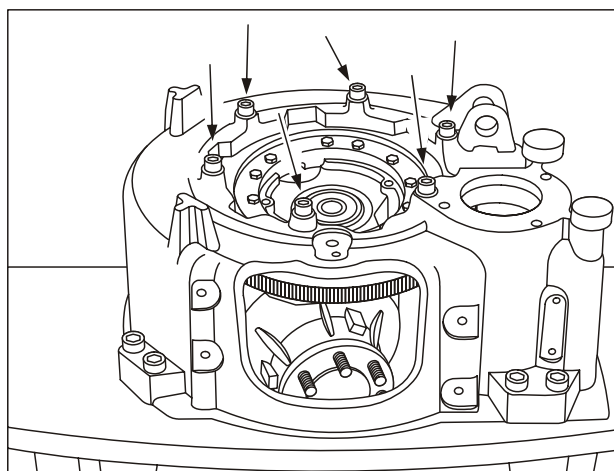
1. Place the gear in a standing position on the floor under the truck.



2. Lower the truck over the gear.
3. Place three screws, M12x110 mm, in the fixing holes to hold the gear in place.



4. Raise the truck and place spacers under the gear.
5. Lower the truck over the gear.
6. Screw the gear in tight. Tighten to 97 Nm.



7. Raise the truck and place the drive wheel. Hand tighten the nuts as tight as possible.
8. Lower the truck onto the wheel.
9. Tighten the drive wheel nuts to a torque of 130 Nm.

Drive gear 2000

General

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Placing the steering motor in the truck

See the section "Steering motor, fitting to the truck".

Placing the drive motor in the truck

See the section "Fitting the drive motor to the truck".

10.1.5 Refitting

1. Refit the floor and pedals. Join the connector unit for the pedal harness.
2. Refit the fender behind the drive wheel and step.
3. Function test the truck.

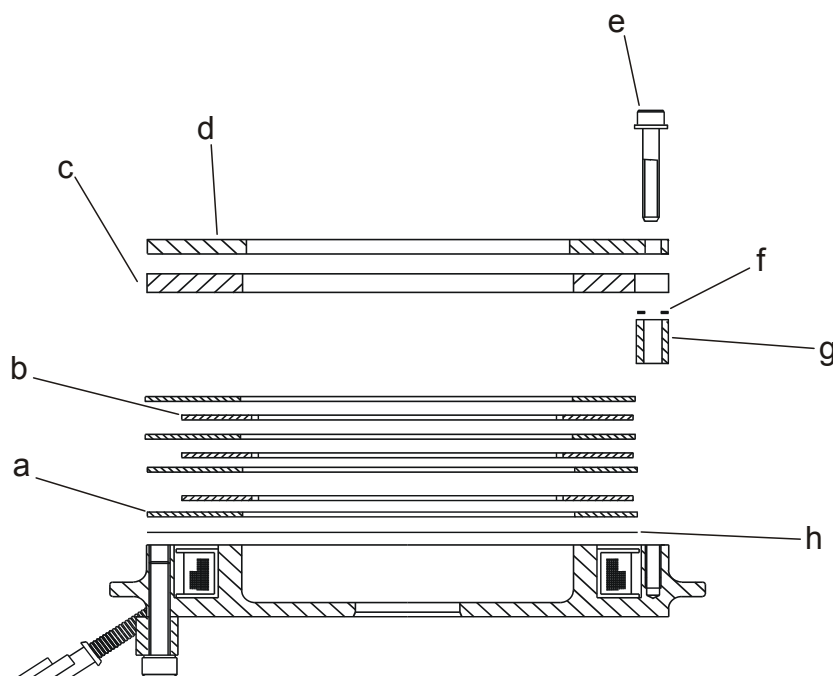
11 – Brake and wheel 3000

11.1 Travel brake system (3100)

11.1.1 Removing the support arm's multiple disc brake

See the section "Removing the support arm wheel from the truck".

11.1.2 Dismantling the multiple disc brake



1. Lift the brake from the support arm wheel.
2. Place the brake on a clean, dry work bench with the end plate (d) uppermost.

IMPORTANT!

Take care that the components and cable harness are not damaged during this and subsequent operations.

3. Undo and remove the six M6x40 allen screws (e) and their washers.
4. Remove the aluminium end plate (d).

IMPORTANT!

Make a note of the number of shims (f) on each spacer (g).

5. Lift off the pressure plate (c) and the disc unit which consists of 4 outer discs (a) and three inner discs (b).
6. Remove the brass plate (h).

Brake and wheel 3000

Travel brake system (3100)

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Inspection

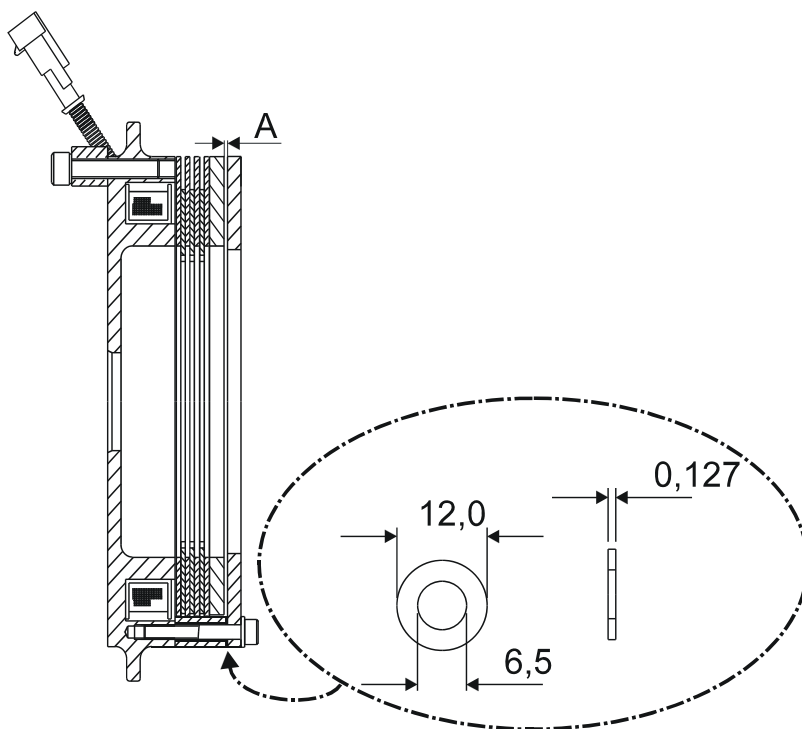
1. Check the thickness of the discs.
The nominal thickness of a new disc = 2.0 mm.
Limit for wear = 1.4 mm.
2. When replacing discs:
Replace all inner and outer discs at the same time. Do **NOT** replace individual discs.
3. Check that the discs are flat and that there is no damage to the splines or the recess.
4. Check the electrical resistance of the magnetic coil.
Nominally 47.7 ohms at 20°C.

IMPORTANT!

The resistance measurement can be made with the brake/wheel fitted to the truck.

Adjusting play

1. Connect the brake to 48 V DC.



2. Check the amount of play, measurement A, with the brake engaged.

IMPORTANT!

Check play at two points simultaneously, with 180° between the points.

3. Maximum permitted play = 2.25 mm.
4. Nominal play on a newly adjusted brake should be 1.0 - 1.25 mm.
5. To adjust, remove the aluminium end plate.

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- Remove the shims (f) when adjusting due to wear, or add shims when replacing with new discs.
Each shim is 0.127 mm thick.
- Fit the aluminium end plate, connect to 48 V DC and check play.
- Once play is within the nominal permitted limits, fit the brake to the wheel and the wheel to the truck.

Assembling the multiple disc brake

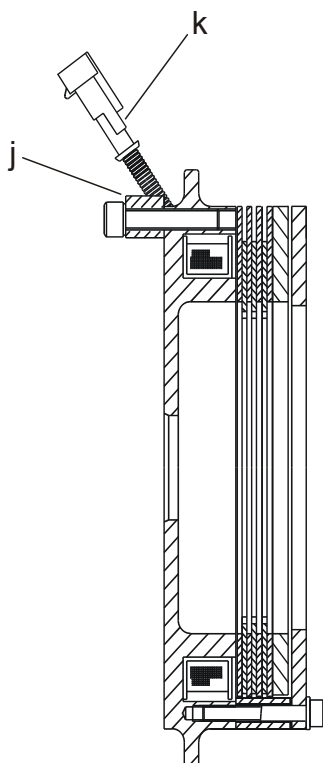
- Clean the parts carefully.

IMPORTANT!

Use only a wire brush and dry cloth for cleaning.

- Assemble the brake in reverse order.
- Connect the brake to 48 V DC.
- Check play between the end plate and the pressure plate (brake disengaged). Adjust play if necessary.

11.1.3 Placing the multiple disc brake in the truck



- Check that the brake engages and releases when intended. Connect the brake to 48 V DC. Switch the power off and on.
- Check that the play between the end plate (d) and the pressure plate (c) is 1.0 - 1.25 mm with the power on (brake disengaged). Play may need adjusting, see the section "Adjusting play".

IMPORTANT!

Check play at two points simultaneously, with 180° between the points.

- Place the brake in the support arm wheel. Make sure that the splines of the inner discs are positioned correctly so that they reach the splines on the wheel hub without being obstructed.
- Fit the wheel to the support arm - see the section "Placing the support arm wheel in the truck".
Make sure that the locking shoe (j) is seated correctly in its recess in the support arm.
- Connect the brake cable harness (k) and check the braking function by pressing the brake pedal fully down.

11.2 Parking brake (3300)

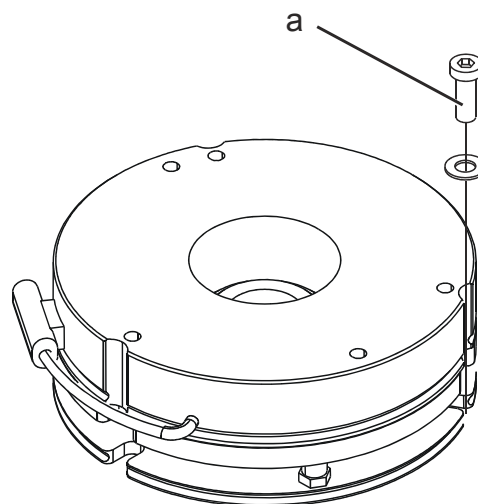
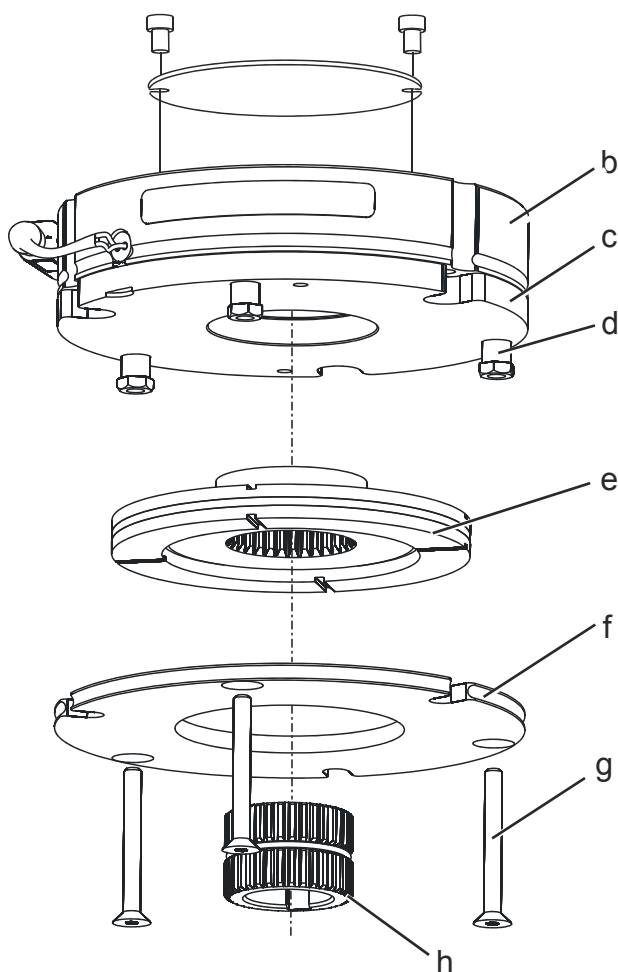
11.2.1 General

The parking brake is a single-stage electromagnetic spring-assisted brake which is activated when its magnetic coil is not powered.



DANGER!

The brake is a safety component. Do not interfere with the brake components.



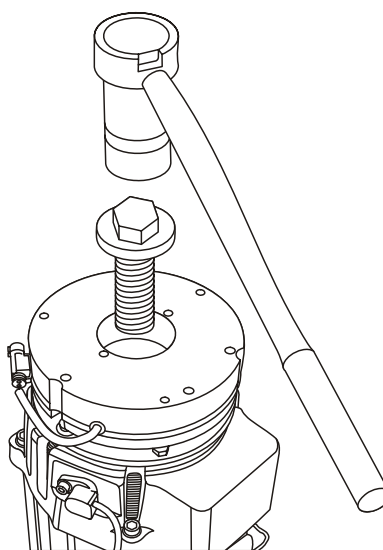
- a. Fixing screws
- b. Magnet housing
- c. Pressure plate
- d. Adjusting screws
- e. Friction disc
- f. Pressure place (fixed)
- g. Mounting screws
- h. Hub

11.2.2 Emergency release of the parking brake

If the parking brake will not disengage due to some fault other than the parking brake itself being broken, there is a power switch in the fuse box under the truck's foot step which energises the parking brake directly, even if the truck is not in use.

If the parking brake does not work at all, it must be removed from the truck – see section "11.2.4 Removing the parking brake from the truck".

11.2.3 Checking the brake force



1. Raise the truck so that the drive wheel is free of the ground.
2. Open the motor compartment hood.
3. Remove the cap at the centre of the parking brake (2.5 mm allen screws).
4. Insert the M12 bolt in the hole in the motor shaft (for lifting), and screw in. Use a torque wrench and an M12 flange bolt, or a normal bolt with a flat washer. The maximum length of the M12 bolt should be 20 mm.

Torque wrench setting: 90 Nm.

IMPORTANT!

Bolt grade must be at least 10.9.

5. Using the torque wrench, turn the motor shaft until the brakes are released.
6. The braking force is too low if the brake is released before the torque wrench starts to slip.
7. Adjust brake play to the correct value – see the section "Adjusting play".
Check the brake force once more using the torque wrench.

Brake and wheel 3000

Parking brake (3300)

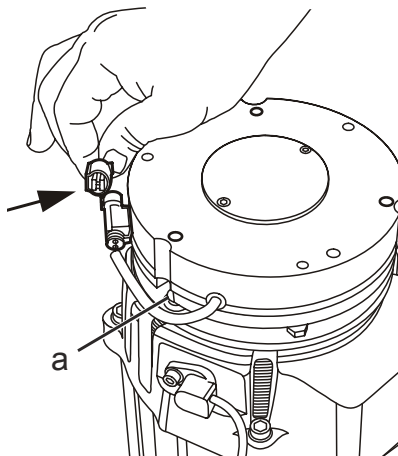
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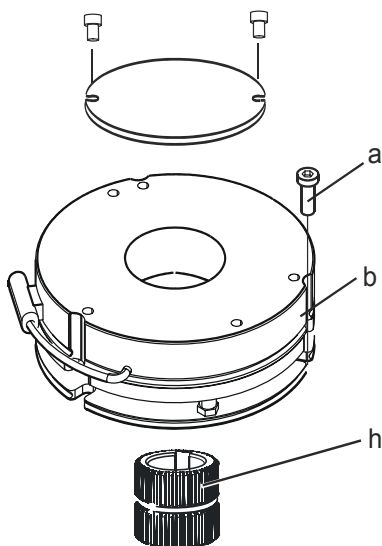
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11.2.4 Removing the parking brake from the truck

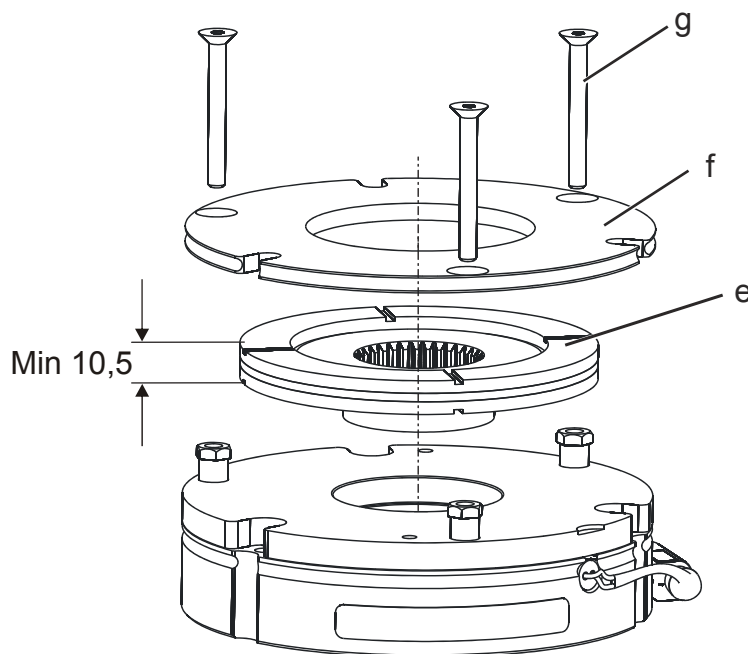


1. Switch off the truck and open the motor compartment.
2. Remove the electrical connection of the parking brake (arrow) that links it to the truck's electrical system.
3. Remove the three screws (a) (5 mm allen screws) that hold the parking brake in position on the motor. (The allen key can be inserted down the holes in the brake that are at each screw position.)
4. Remove the brake unit from the motor shaft. The spline sleeve (h) can be taken out with the brake or can remain on the motor shaft.

Dismantling and checking wear



1. Place the brake on a clean dry workbench with the magnet housing (b) facing downwards.
2. Undo the 3 mounting screws (g) (locked with thread locker).
3. The brake unit can now be dismantled for inspection of its component parts.
4. Measure the thickness of the friction disc (e). Min. thickness: 10.5 mm



Assembling the parking brake

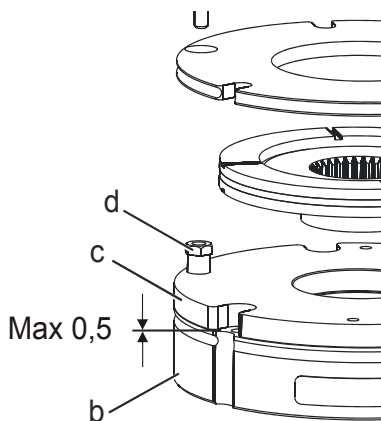
1. Clean the parts carefully.

IMPORTANT!

The friction surfaces must not come into contact with oil or grease, as this will seriously reduce brake force.

2. Assembly of the brake is the reverse of dismantling.
3. Bear in mind the following:
 - The hub of the friction disc (e) must fit the corresponding hole in the magnet housing.
 - Play must be set correctly. Some adjustment may be necessary.

Adjusting play



1. Play between the pressure plate (c) and magnet housing (b) is adjusted using the adjusting screws (d).
2. Play may not exceed the maximum permitted value before adjustment is required. Use a feeler gauge to measure it.

Maximum permitted play: 0.50 mm

Nominal play: 0.3 ± 0.1 mm.

3. Slightly loosen the mounting screws (g).
4. Adjust play using the adjusting screws (6).
5. Turn anticlockwise to increase play and clockwise to reduce it.
6. Tighten the mounting screws (g) to 20 Nm.
7. Check play again once the screws have been tightened.
8. Repeat the adjustment stage until play is correct.
9. Check play all the way around the pressure plate. The maximum permitted deviation from the play setting is 0.075 mm.

Brake and wheel 3000

Parking brake (3300)

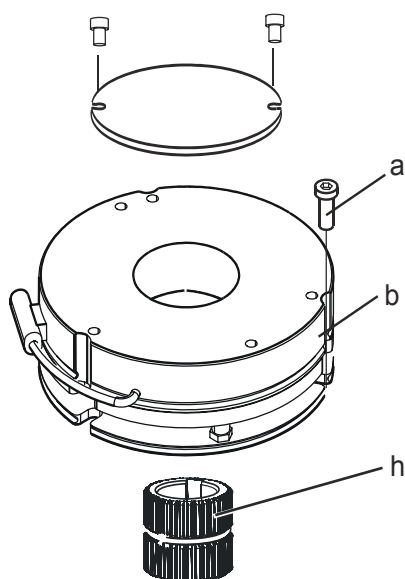
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11.2.5 Placing the parking brake in the truck

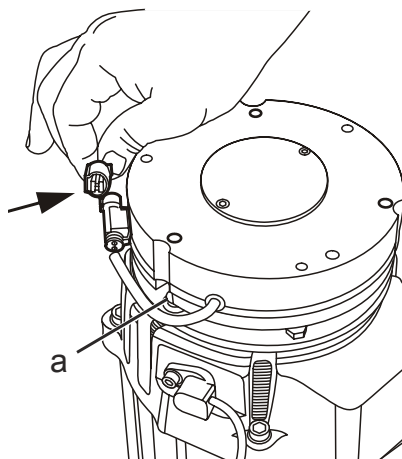


1. Place the key and hub (h) on the motor shaft.
2. Fit the brake on the hub.
3. Check before fitting the brake that the friction disc is centred in relation to the magnet housing.
 - It may be necessary to apply 48 V DC to the magnetic coil to position the friction disc correctly.
4. Insert the fixing screws for the brake unit (a) (5 mm allen screws) and tighten them to 17 ± 1.7 Nm.
5. Place the cap over the centre of the brake.
6. Check play between the magnet housing and the pressure plate with the brake fitted.
7. Connect the brake cable to the truck's electrical system (arrow).
8. Start the truck and release the parking brake.
9. Check that the friction disc rotates freely.

Cut the voltage and check that the pressure plate locks the friction disc and that play is correct.

IMPORTANT!

***Do not hammer the friction disc onto the motor shaft, as cracks may occur on the brake disc resulting in it breaking.
Push the friction disc onto the motor shaft instead.***



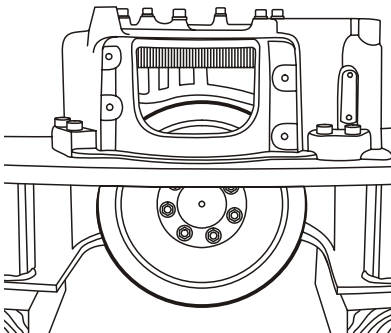
11.3 Drive wheel (3530)

11.3.1 General

To avoid heavy and uncomfortable lifting when changing the drive wheel, you can use a board or a plate (or two, if the board or plate does not easily slide against the floor surface).

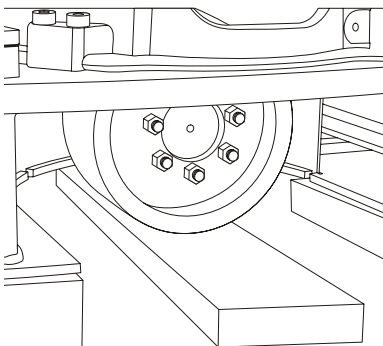
11.3.2 Removing the drive wheel from the truck

1. Pull out the battery cut-out connector.
2. Remove the fender by the drive wheel.
3. Raise the truck by approximately 1 cm. Remember to secure the truck with spacers to prevent it coming down onto its chassis if the jack fails.
4. Turn the drive wheel so that the nuts are facing you. Apply an iron bar against the gear rim, taking care that the teeth do not become damaged.
5. Raise the truck so that a plank/plate can be inserted under the drive wheel. This is then used to extract and insert the wheel under the truck.
6. Undo the 7 nuts, and remove them and the washers.
7. Pull the wheel from the gear - the truck may need to be raised slightly as you do this.
8. Once the wheel is on the plank, raise the truck by approximately 10 cm plus the thickness of the plank.
9. Using the plank, extract the wheel.



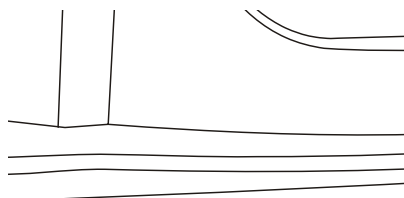
11.3.3 Placing the drive wheel on the truck

1. Roll the new wheel onto the plank and insert the wheel and plank under the truck.
2. Align the wheel holes so that they line up with the stud bolts.
3. Lower the truck at the same time as inserting the wheel against the gear.
4. Lower the truck so that the stud bolts are at the height of the holes on the wheel.
5. Insert the plank with the wheel so that the wheel finds its proper position.
6. Fit the washers and nuts.
7. Tighten the wheel nuts - tightening torque 130 Nm.
8. Refit the fender by the drive wheel.

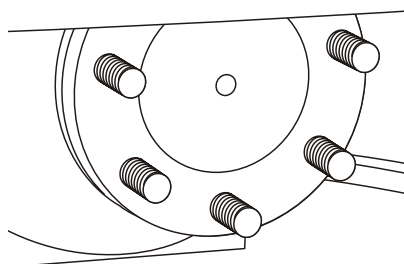


11.4 Wheel bolt (3530)

General



The wheel bolts on the drive gear are stud bolts threaded in the hub.



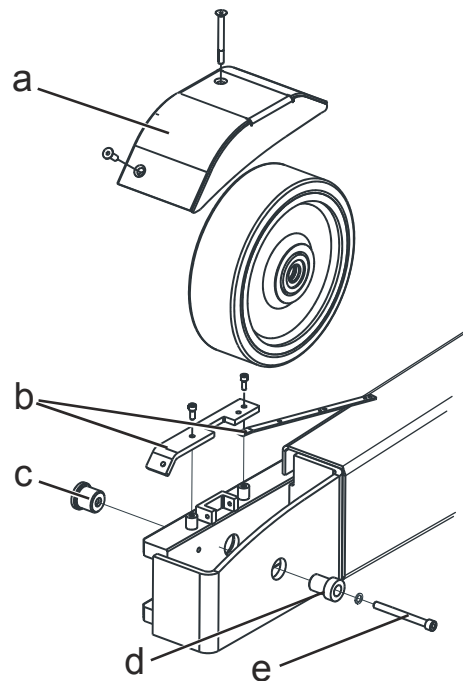
11.4.1 Replacing wheel bolts

1. Remove the drive wheel - see the section "Removing the drive wheel from the truck".
2. Wheel bolts with damaged threads are removed using the stud bolt tool.
3. Broken wheel bolts:
 - **Method 1:** Drill a hole in the centre of the bolt and screw out the bolt using a screw extractor for M14 bolts.
 - **Method 2:** If the bolt will not come loose with a screw extractor, the bolt must be drilled out.
 - Centre punch the centre of the bolt; be precise when centring the punch.
 - Drill a pilot hole through the bolt using a 5 mm bit.
Drill out the bolt using an 11.5 mm bit.
 - Try to remove the remains of the bolt with pliers or a similar tool.
If that does not work, remove the remains by clearing the threads with a M14x1.5 tap.
4. Smear some LOCTITE 270 onto the thread of the wheel bolt.
Place the new wheel bolt using the stud bolt tool.
Tightening torque: 80 Nm.
5. Place the drive wheel - see the section "Placing the drive wheel on the truck".
6. Insert the battery cut-out connector.

11.5 Support arm wheel (3550)

11.5.1 Removing the support arm wheel from the truck

1. Raise the truck and support it using blocks so that the support arm wheel is free of the floor.
2. Remove any guard (a) on top of the support arm wheel.
3. Remove the protective cover (b) on top of the cable to the braked support arm wheel and pull out the cable until the connector unit in the support arm can be accessed. Undo the connector unit.
4. Unscrew the screw (e) 1 cm and tap it in so that the axle (c) is ejected from the support arm.
5. Remove the screw (e) and screw an M16 screw into the axle (d) and extract this from the support arm.
6. Remove the support arm wheel.



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Support arm wheel (3550)

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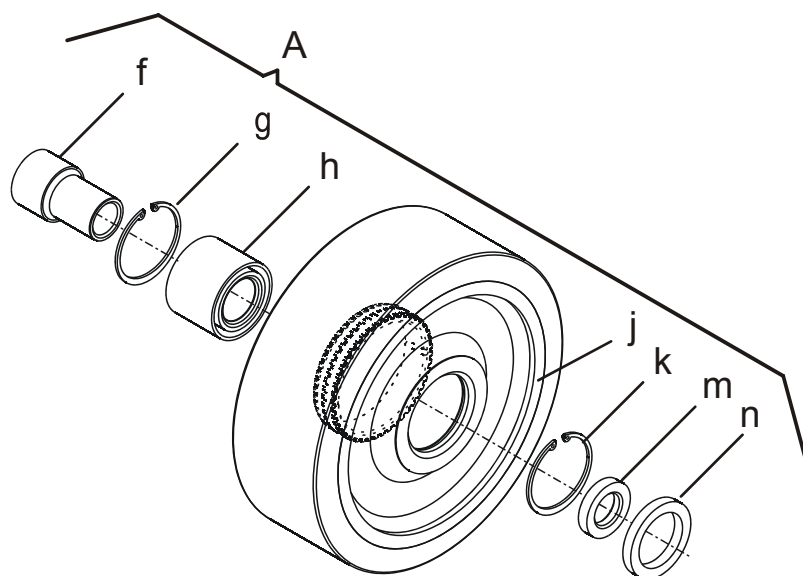
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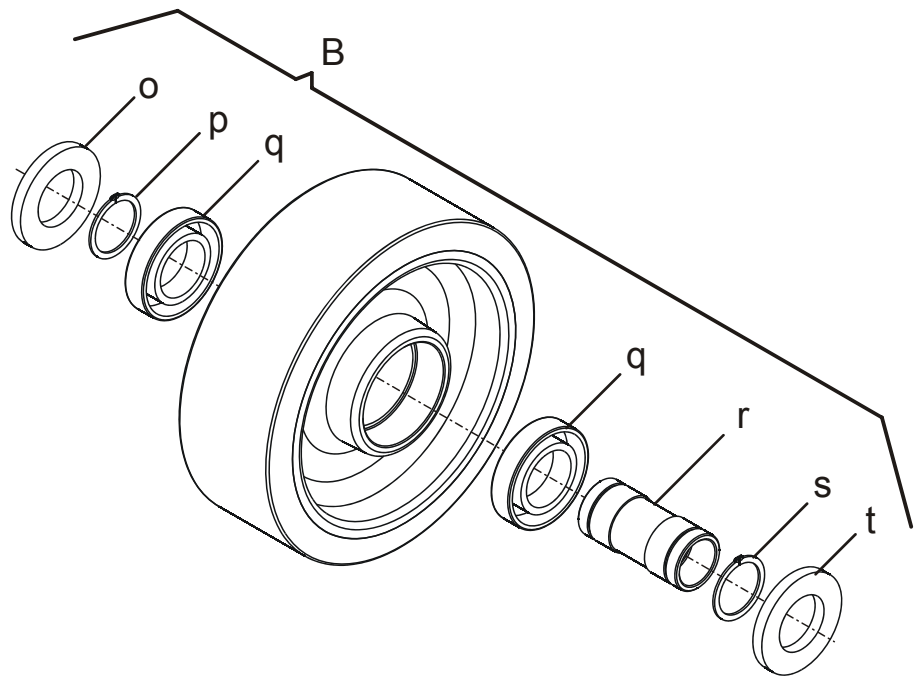
11.5.2 Replacing a wheel bearing – braked wheel (A)

1. Remove the spacer rings (n), (m) and locking rings (g, k).
2. Tap out the bearing (h) and axle (f).
3. Fit a new bearing to the axle (f).
4. Insert the locking ring (k) in the wheel.
5. Insert the bearing and axle in the wheel.
6. Fit the other locking ring (g).
7. Insert the spacer rings (n) and (m) in the wheel.



11.5.3 Replacing a wheel bearing – unbraked wheel (B)

1. Remove the sealing rings (o, t) and the locking rings (p, s).
2. Tap out the bearing (q) and axle (r).
3. Turn the wheel over and remove the other bearing (q).
4. Fit a new bearing to the axle (r).
5. Place the locking ring (p) on the axle outside the bearing.
6. Place the bearing and axle in the wheel.
7. Place the other bearing (q) in the wheel and place the locking ring (s) on the axle.
8. Place the washers (o, t) on the wheel.



Brake and wheel 3000

Support arm wheel (3550)

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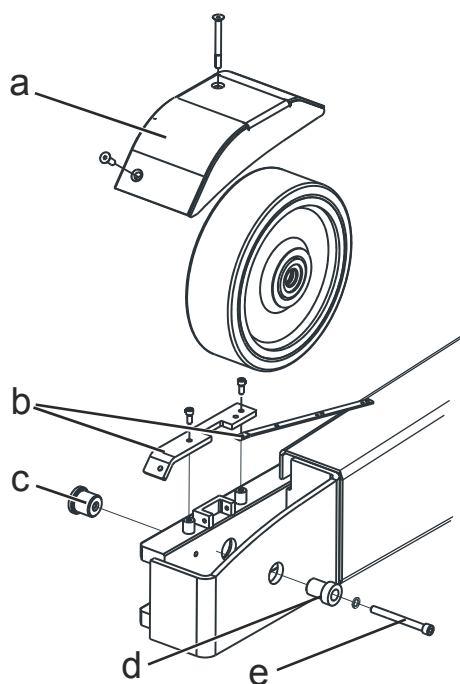
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11.5.4 Placing the support arm wheel in the truck

1. Position the support arm wheel correctly in the support arm.
2. Insert the axle (c) and (d) correctly in the support arm.
3. Place the screw (e) and washer in the axle - tightening torque 83 Nm.
4. Braked wheel:
Connect the brake connector unit to the cable in the support arm.
Thread the connector unit into the support arm.
Replace the protective cover (b) on top of the cable.
5. Replace any guards (a, b) on top of the support arm wheel.
6. Let the support arm down and function test the truck.



12 – Steering system 4000

12.1 Electric steering wheel (4310)

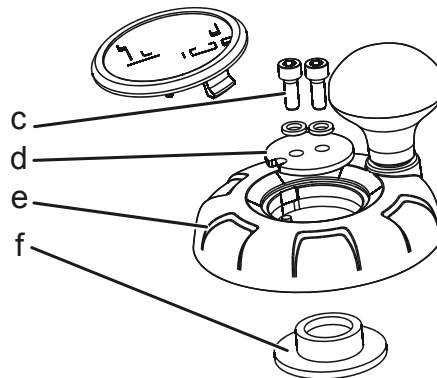
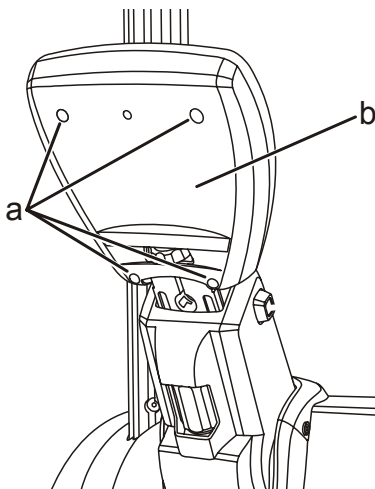
12.1.1 General

The steering wheel module has a pulse transducer fitted under the steering wheel. The pulse transducer can be replaced without removing the operating console from the truck.

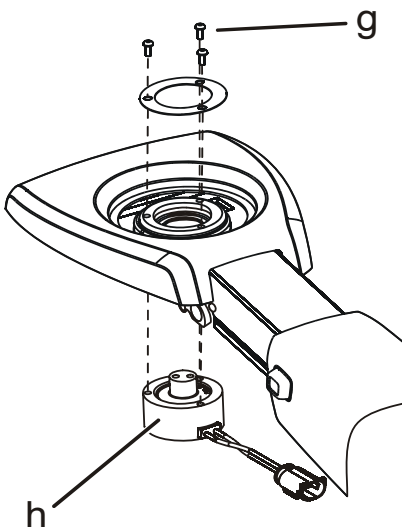
If the wiring harness inside the operating console must be replaced, the entire operating console should be removed from the truck.

12.1.2 Replacing the pulse transducer on the steering wheel module

1. Remove four screws (a) (torx 10) from the underside of the steering wheel module.
2. Remove the bottom panel (b).
3. Remove the disc with the logo from the centre of the steering wheel.
4. Remove two screws (c) (torx 20) and the washer (d).
5. Remove the steering wheel (e) and the spacer (f).



6. Undo the connector unit for the pulse transducer.
7. Remove the three screws (g) (torx 20) that hold the pulse transducer (h) in place.
8. Reassemble in reverse order.



Steering system 4000

Electric steering wheel (4310)

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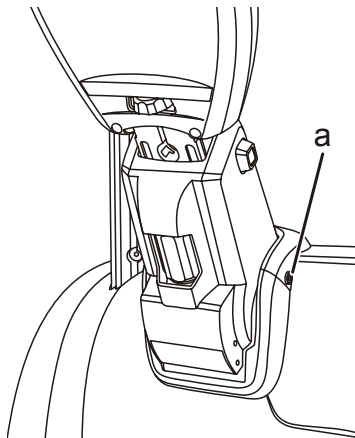
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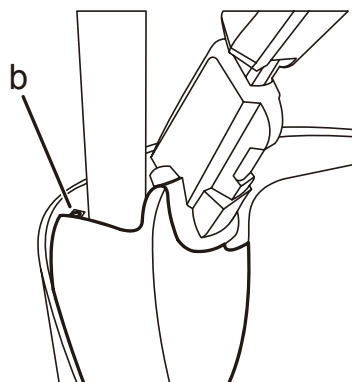
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12.1.3 Removing the operating console from the truck

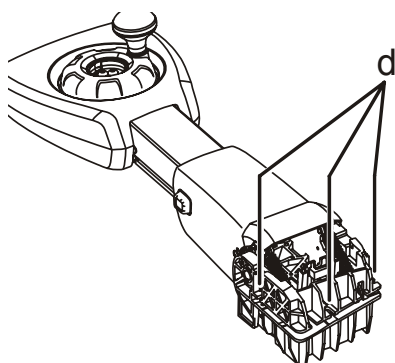
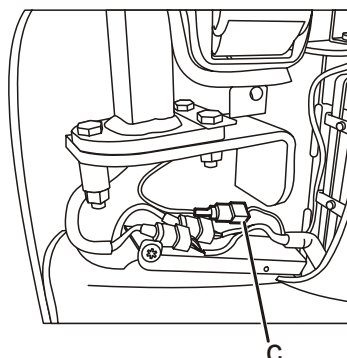
1. Expose the operating console by removing the screw (a) on the right-hand side of the tiller arm and remove the panel.



2. Remove the screw (b) for the other panel section, located in front of the tiller arm. Remove the entire panel.



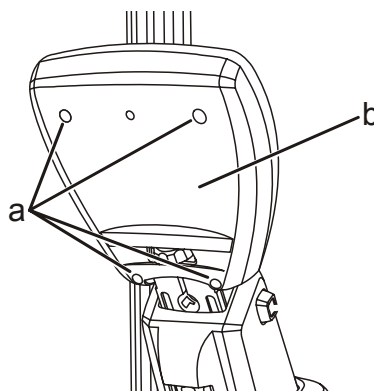
3. Undo the connector unit (c) by the wall.



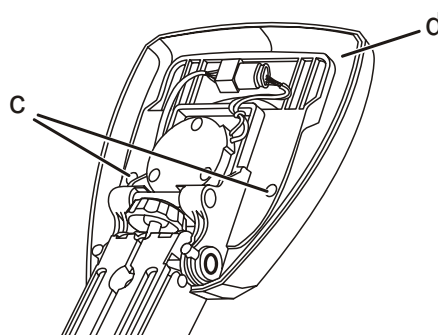
4. Remove the three screws (d) (torx 30) that hold the operating console in place and remove the operating console from the truck.

12.1.4 Replacing the wiring harness in the operating console

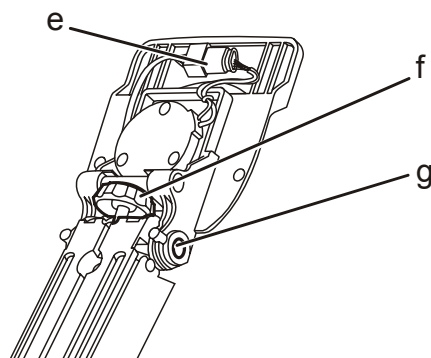
1. Remove four screws (a) (torx 10) from the underside of the steering wheel module.
2. Remove the bottom panel (b).



3. Remove two screws (c) (torx 10) together with the pulse transducer.
4. Remove the top panel (d).



5. Undo the connector unit (e) by the transducer.
6. Remove the screws (torx 25) and sleeve (g) by the steering wheel module joint.
7. Unscrew the adjusting screw (f) all the way so that the steering wheel module is free of the operating console.



Steering system 4000

Electric steering wheel (4310)

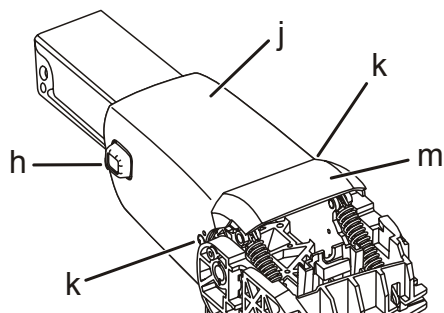
T-code
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Valid from serial number
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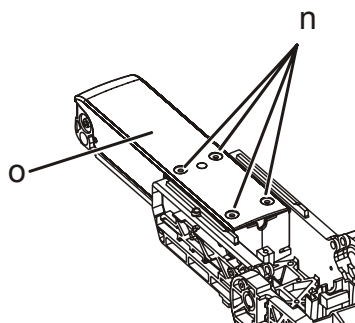
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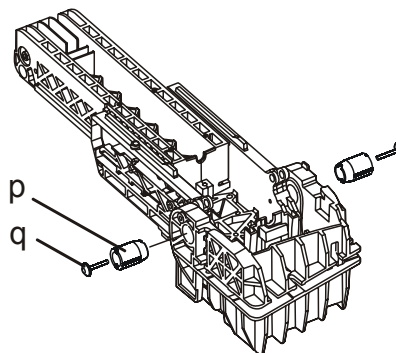
8. Prise the button (h) free of the operating console.
9. Remove the two screws (k) (torx 10) and remove the casing (j) from the operating console.
10. Remove the panel (m) from the operating console.



11. Remove the four screws (n) (torx 15) and the cap (o).



12. Remove the screws (p) (torx T25) and sleeve (q) by the joint with the operating console's fixing point.
13. Note how the cable is fixed in the operating console and then remove the cable.

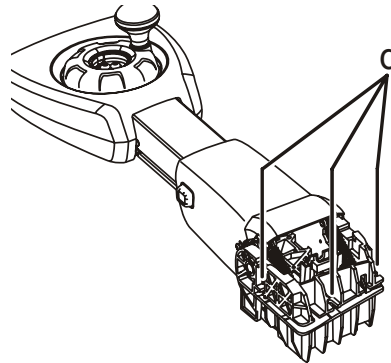


14. Place a new cable and reassemble in reverse order.

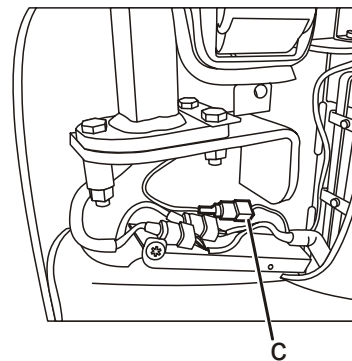
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12.1.5 Placing the operating console in the truck

1. Place the operating console on the truck.
2. Tighten the three screws (d) (torx 30) that hold the operating console in place.



3. Connect the connector unit (c) by the wall.



4. Refit the panels around the operating console.

Steering system 4000

Steering reference sensor (4350)

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12.2 Steering reference sensor (4350)

General

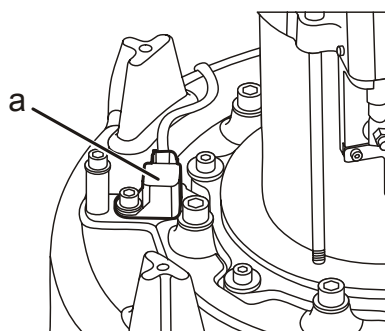
These instructions apply for replacement of the steering reference sensor located on the drive gear housing, up against the drive motor.

When replacement of the sensor is due, first remove the floor, as described in the section "Replacing the drive gear".

12.2.1 Replacing the reference sensor

The sensor does not need adjusting on replacement.

1. Remove the screw holding the old sensor (5 mm allen screw).
2. Undo the connector unit for the sensor.
3. Place the new sensor and screw it tight.
4. Connect the harness.
5. Refit the floor.



12.3 Steering bearings (4380)

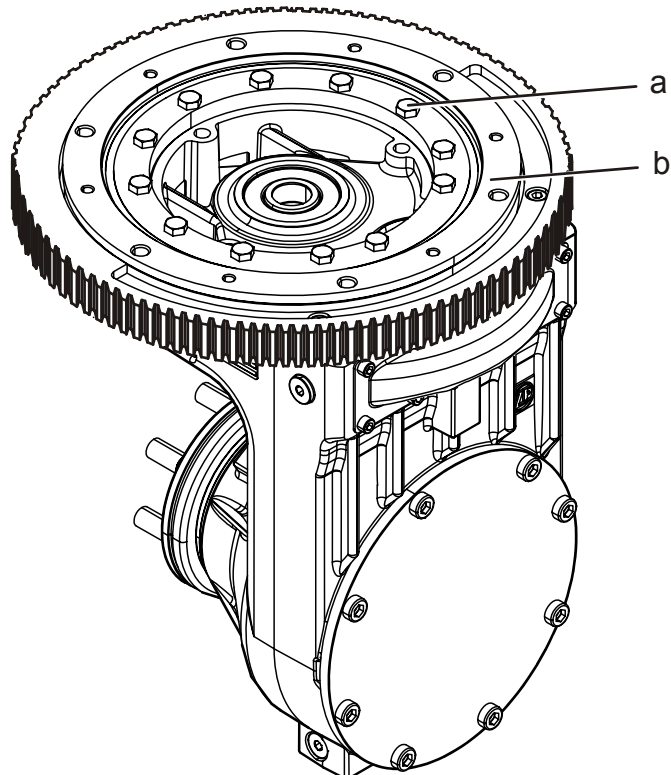
If the steering bearing has to be replaced, remove the drive gear as in the instructions - see the section "Replacing the drive gear".

12.3.1 Removing a steering bearing from the drive gear

1. Undo the screws (a) and remove the steering bearing (b) from the drive gear.

12.3.2 Placing a steering bearing on the drive gear

1. Apply Loctite 242 to the screws (a).
2. Using the screws (a), place the steering bearing (b) on the drive gear.
Tightening torque 23 Nm.



Steering system 4000

Steering bearings (4380)

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13 – Electrical system 5000

13.1 Battery (5110)

13.1.1 Battery recommendation

Exide gel batteries (Sonnenschein, for example)

In BT's tests with Exide gel batteries, no recommendations were obtained for parameter setting on any of BT's products.

BT does not therefore recommend these batteries.

Hawker Evolution gel batteries

After carrying out trials and tests, there are recommended parameter settings for RRE with the Hawker Evolution gel battery. There are also instructions for verifying and adjusting the set values.

These are the batteries that BT recommends.

There are clear guidelines on how to use Hawker Evolution gel batteries.

- Evolution batteries are designed for low intensity use.
- Recommended use is one shift per day (a maximum of 8 hours).
- Weekly maximum is 6 days per week, with a limit on expected service life of 1000 cycles.
- Maximum depth of discharge is 70 %.
- The ambient temperature should be between +5 °C and +35 °C.
- The battery should be charged with a Hawker battery charger complete with EZ control. Charging must be performed in line with Hawker's instructions.
- The usual charging time is 12 hours.
- Equalising charging is required after 6 charging cycles.
- It is not permitted to store discharged batteries. The longest permitted storage period is 2 months, but this must involve charging once per month.

13.1.2 Battery installation

IMPORTANT!

Parameter no. 107 must always be checked and adapted to the battery that is installed in the truck. The parameter settings depend on battery type, truck type, battery size and the truck application.

13.1.3 Setting battery parameters

Parameter settings for valve-controlled batteries (VRLA)

BT recommends that when setting parameter 107 in a Reflex truck with Hawker Evolution batteries, the recommended value for wet batteries should be reduced by six (6) units.



DANGER!

The battery's service life will be reduced if the value of parameter 107 is set to a value that is too high. Always check that the parameter settings are correct, using the instructions below as an aid.

When checking the charging state on a discharged 48 V battery, its no-load voltage should be measured after a rest period. There should be zero indication in the case of no-load voltage, which should not be less than 2.02 V/cell or 48.48 V.

See the instructions below.

Instructions for verifying parameter settings

1. Charge the battery.
2. Use the truck in its normal application until the battery indicator shows a discharged battery (0 % on the display).
3. Disconnect the battery from the truck and let the battery rest for at least two hours.

IMPORTANT!

Do not charge or discharge during this time.

4. Measure the voltage on the battery at +20 °C. If the voltage is less than U_{end} (see the table below), **the** parameter value must be reduced. A value substantially above U_{end} reduces the risk of damage to the battery. At the same time, the operating time of the truck is reduced. If a longer operating time is required, the parameter value can be slightly increased.
5. Each change must be followed by renewed verification of the parameter setting.

Battery type	Battery voltage at rest, U_{end}
Hawker Evolution	48.48 V

13.2 Control console (5510)

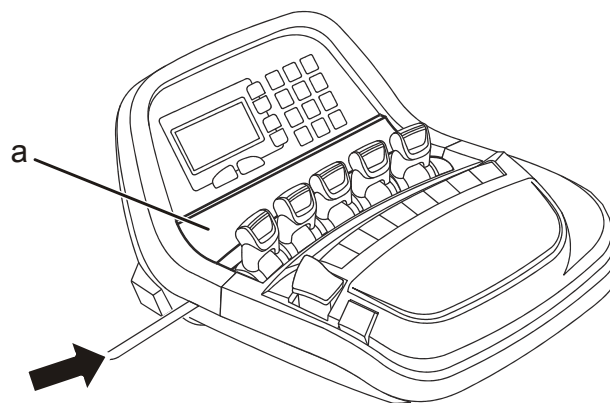
13.2.1 General

The control console is available in two versions, with either four or five separate controls (potentiometers) or with a multifunction control. In what follows, there is a description of how to work on a control console with separate controls.

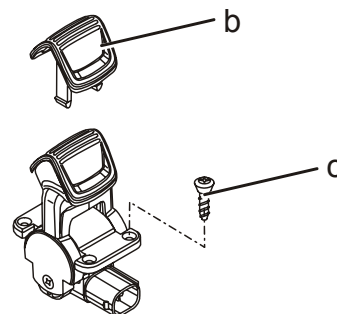
13.2.2 Replacement/installation of a control

An extra control (a fourth and fifth hydraulic function) can be fitted to the cable harness already present.

1. Insert a feeler gauge (arrow) on the side of the control console, at the joint in the panels.
2. Remove the cover (a).



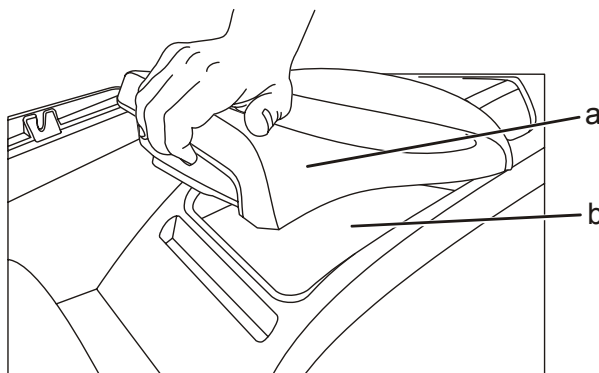
3. Undo the four screws (c) (torx 10) that hold the control.
4. Lift the control up.
5. Disconnect the control from the cable harness.



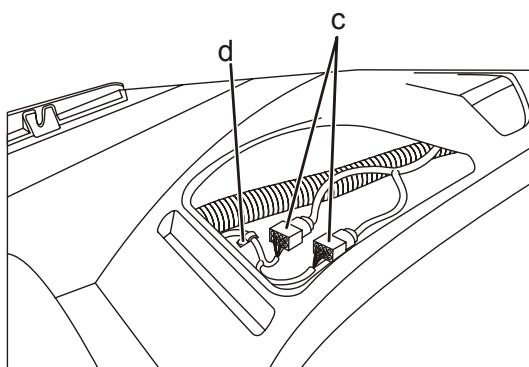
6. If the symbol/top (b) on a control is to be replaced:
 - Using a pair of narrow pliers, press together the two locking pins that are visible on the underside of the control arm, next to the potentiometer.
 - Pull the top of the control upwards.
 - Press the new top tightly into place on the control.
7. Reassemble in reverse order.

13.2.3 Removing the control console from the truck

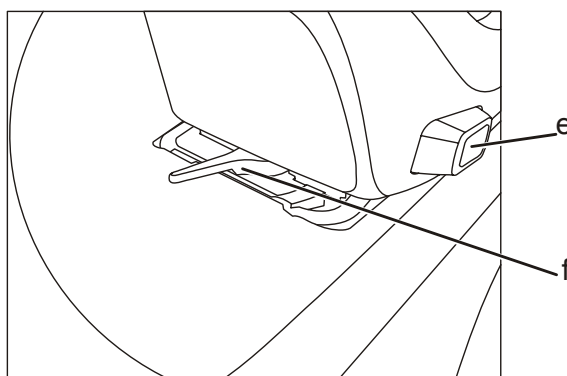
1. Remove the armrest (a) and the box (b) under the armrest.



2. Undo the two contacts (c) under the armrest.
3. Remove the cable clamp (d) (10 mm hex).



4. Press in the catch (e) on the control console's side and push the console into its rear position.
5. Rotate the catch (f) out, so that it points straight out of the control console.



6. Release the control console by lifting it straight up. Take care that the catch does not break off.
7. Remove the control console with its attendant wiring harness; be careful with the connector units.

13.2.4 Replacing the access card's circuit board



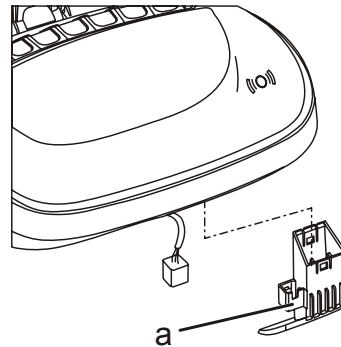
WARNING!

Static electricity!

Risk of static discharge that can damage the electronics.

Before starting work on the electronics, make sure you take the necessary steps to prevent static electricity, in other words, ESD protection.

1. Insert a screwdriver in the small hole to release the catch that locks the access card unit (a).
2. Undo the cable connection. Angle the access card unit slightly so as to draw it through the hole.
3. Connect the new card and refit.



13.2.5 Dismantling the control console

General



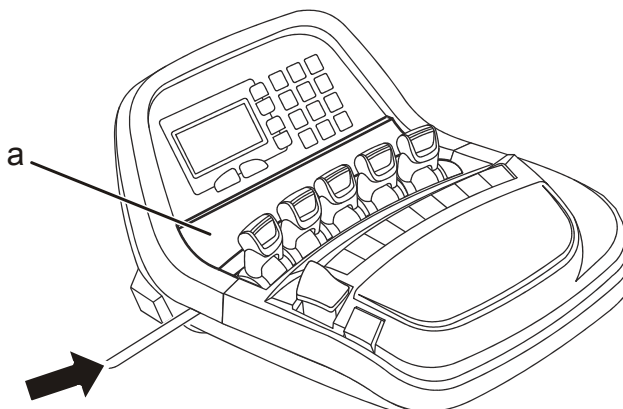
WARNING!

Static electricity!

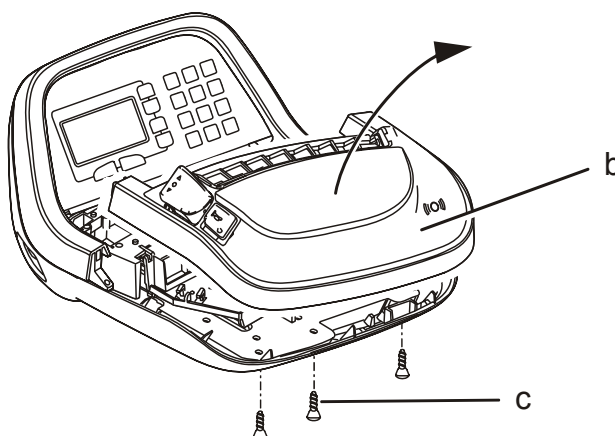
Risk of static discharge that can damage the electronics.

Before starting work on the electronics, make sure you take the necessary steps to prevent static electricity, in other words, ESD protection.

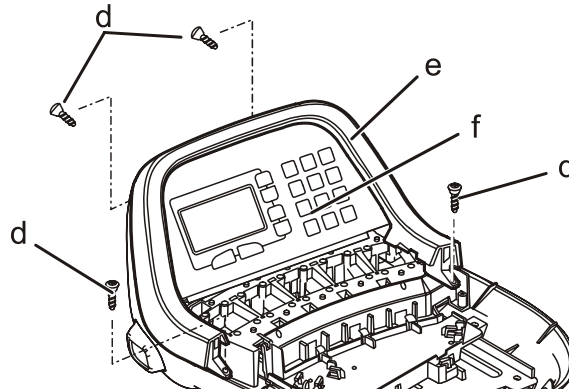
1. Insert a feeler gauge (arrow) on the side of the control console, at the joint in the panels.
2. Remove the cover (a).



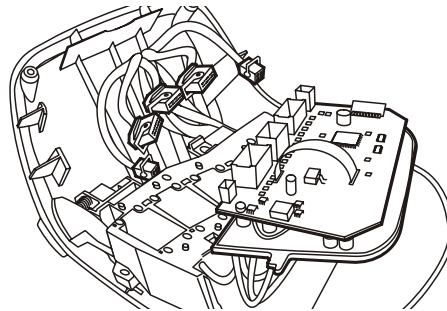
3. Remove the three screws (c) (torx 20) on the bottom of the control console in order to release the lower cover (b).



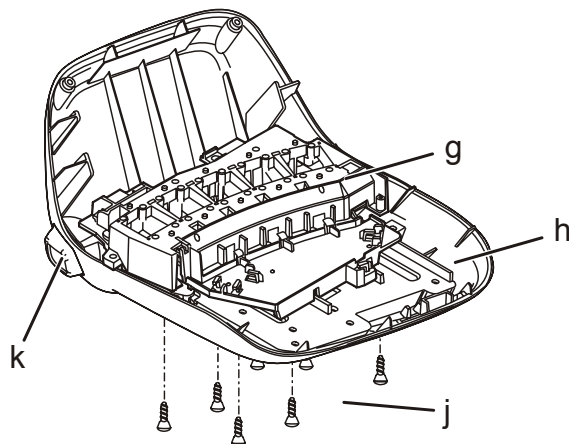
4. Remove the four screws (d) (torx 20) that hold the border (e) around the display (f).



5. Disconnect the cable harness from the display. Use the clamp on the contacts to undo the contact from the circuit board.
6. Remove the border and printed circuit board.



7. Remove the 10 screws (j) (torx 20) from the bottom that hold the inner plate (g) against the bottom section (h).
8. Release the panel adjustment catch (k) from its retainer in the sled and lift the inner plate out (g).

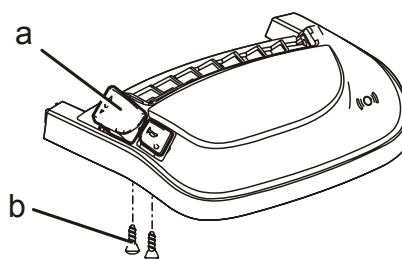


Installing an extra push button

1. Dismantle the control console - see "Dismantling the control console".
2. Install the new cable harness - see the wiring diagram.
3. Connect the cable harness to the display.
4. Refit the inner plate and the adjustment catch in the lower panel.
5. Remove the cover in the upper panel where the new push button is to be fitted.
6. Press the new push button with its symbol firmly into the upper panel.
7. Connect the wiring harness to the push button as specified in the wiring diagram.
8. Refit the control panel.

Replacing the travel direction selector with signal button

1. Carry out items 1–3 as described in the section "Dismantling the control console".
2. Remove the two screws (b) that hold the selector (a) in the panel.



3. Undo the cable connection and remove the selector from the panel.
4. Reassemble in reverse order.

Replacing the display



WARNING!

Static electricity!

Risk of static discharge that can damage the electronics.

Before starting work on the electronics, make sure you take the necessary steps to prevent static electricity, in other words, ESD protection.

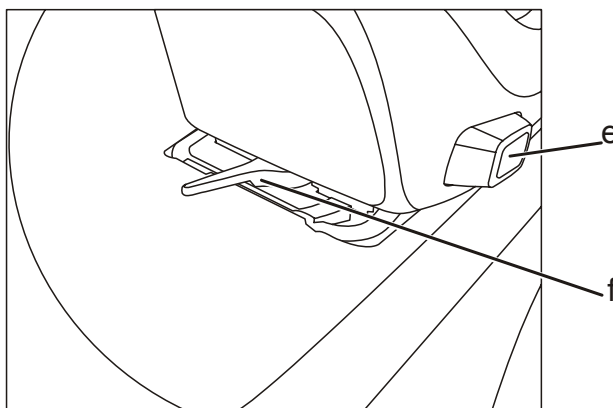
1. Carry out items 1–6 as described in "Dismantling the control console".
2. Carefully prise the display out of its border and install the new display.
3. Make sure the locking catch is fully down, and insert the contact in the display. Press together, and use the catch to pull the contact together; then lock the catch in place on the contact.
4. Reassemble in reverse order.

13.2.6 Assembling the control console

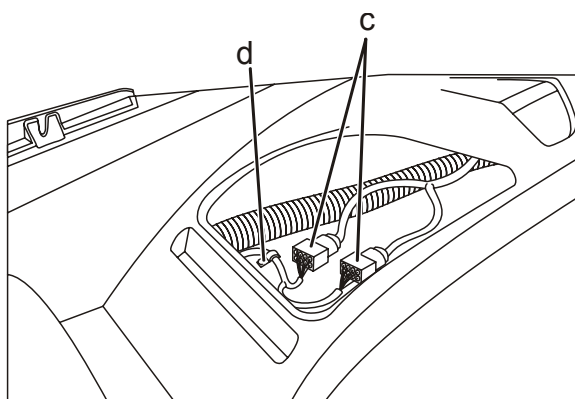
Reassemble in reverse order.

13.2.7 Placing the control console in the truck

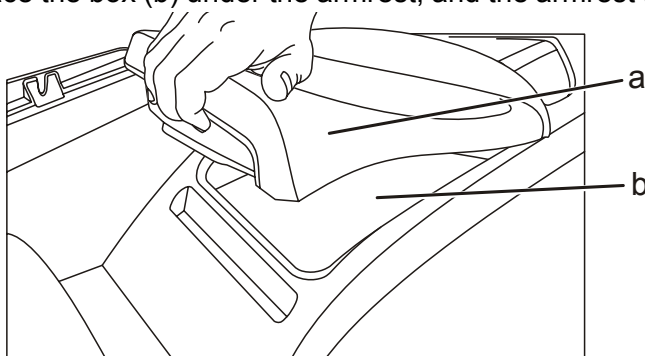
1. Put the wiring harness of the control console back in place. Insert the connector units behind the panel and push them in towards the opening near the armrest.
2. Place the control console in the track for the sled.
3. Push the console in until it reaches its rear position.
4. Rotate the catch (f) so that it points to the side.



5. Connect the two contacts (c) under the armrest.
6. Place the cable clamp (d) (10 mm hex).



7. Replace the box (b) under the armrest, and the armrest (a).



13.3 Parameter settings

13.3.1 Configuration menu

Calendar/hour counter menu

The calendar and hour counter menu display hour counter and calendar data. If a service key is connected, the date and time can be changed.



To set the current date and time, use the arrow keys to select the value to be changed (hours, minutes, month and day), as well as the plus/minus buttons to make the changes. The new settings are stored in the MCU by pressing the green button (I).

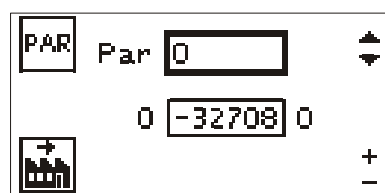
The hour counter menu displays the values for hour counters A, B, C, D and S:

- A Total time
- B Active time
- C Driving/Operating time
- D Hydraulics time
- S Time until service

If the service hour counter is deactivated, service parameter 101, the service time is not displayed.

Parameter menu (PAR)

To be able to change the parameters, a service key must be connected. If the key is not connected, the parameters can only be read.



Each parameter can be reached by entering the parameter number in the box marked "Par". The parameter value can be entered using the numerical keypad, or the plus/minus buttons.

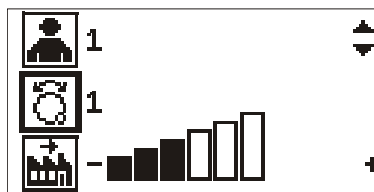
The plus button increases the number by one (1) and the minus button reduces it by one (1).

The value of the parameter is displayed in the box under "Par". The value is changed by using the arrow key to select this box and then entering the value with the keypad or the plus/minus buttons. The value is saved by pressing the green button (I).

The parameter's default value can be selected by selecting the factory icon and pressing the green button (I).

Driver parameter modification

The driver parameters, for the currently logged in driver, can be modified from the Driver Parameter Screen.



The screen shows a driver symbol on the top left of the screen with the current driver profile to the right. On the middle left side of the screen is a symbol representing the current parameter with the parameter number displayed to the right. The bottom left side of the screen shows a factory icon.

A row of bars shows the parameter value. The number of bars depends on the range of parameter values. The bars are filled up to the current parameter value.

The arrow keys are used to move the selection between:

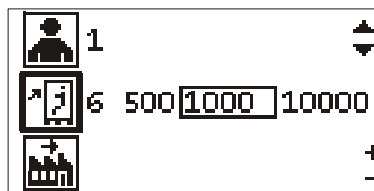
- the parameter icon, where the '+' and '-' keys are used to change the driver parameter
- the factory icon, where the parameter is restored to default value by pressing the green key

and

- the parameter value bars.

When the parameter value bars are selected, the programmed parameter value is indicated by an arrow above the bar representing that value. The value is changed with the '+' and '-' keys and stored by pressing the green key.

The last driver parameter is the parameter for cabin tilt height. This parameter uses a special screen as shown below.



The height is edited by pressing the + and - keys or using the numeric keys.

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PIN menu

The PIN settings menu is used to manage PIN codes. This menu can only be accessed when a service key is connected.

All the PIN codes can be reset to their factory settings by selecting the factory symbol (a) and then pressing the green (I) button. During the time that the information is being stored in the MCU, an hourglass is displayed on the screen.

The PIN block menu (b) and PIN programming menu (c) are accessed from here.

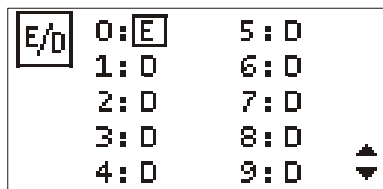
The PIN codes are organised in blocks and profiles, with ten PIN codes for each of the ten operator profiles.



Table 1: Standard PIN code set										
Profile:	1	2	3	4	5	6	7	8	9	10
Block 0	0001	0002	0003	0000	0000	0000	0000	0000	0000	0000
Block 1	7901	1437	3731	1049	9439	7265	1322	2869	1574	5421
Block 2	4854	2907	9175	5799	1490	3031	7392	5622	5023	1787
Block 3	3174	1026	3815	6703	1179	5152	7514	5668	3215	4659
Block 4	7110	5477	3846	9491	5918	8222	6923	8139	7025	9197
Block 5	6276	9879	9658	1690	4042	5201	9807	4332	9715	2549
Block 6	4142	8620	3754	8432	8788	7430	1948	2595	8527	7474
Block 7	1482	7135	2395	7365	7092	4611	2831	4185	6067	1930
Block 8	4731	1022	5377	3257	7334	9009	7881	8843	7436	2876
Block 9	5878	2828	1910	6907	2136	5730	2957	7691	3162	3242

Menu for activating a PIN block

Each PIN block can be activated (E, enable) or deactivated (D, disable) separately.

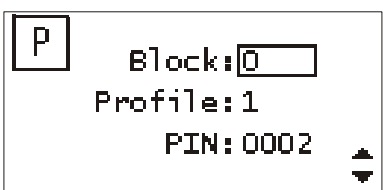


The PIN blocks are listed in two columns with a number from 0 to 9. Active/non-active status is indicated by an "E" or a "D" to the right of each block number.

To change status, use the arrow keys to select a block. Use the plus button to activate the block and the minus button to deactivate it. The value is saved by pressing the green button (I) and the next block in the list is selected.

Menu for programming a PIN (P)

It is possible to program your own PIN codes in this menu.



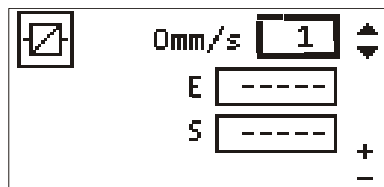
Use the block and profile number to select the PIN code to be changed; the value for the block and profile is changed using the plus/minus buttons or numerical buttons.

A new PIN code is entered using the numerical buttons in the PIN box. The value is saved in the MCU by pressing the green button (I).

13.4 Calibrations

13.4.1 Valve calibration

The valve mode is used to calibrate the valves. Valves that can be calibrated are:



- 1 Free lift
- 2 Free lowering
- 3 Main lift
- 4 Main lowering
- 5 Reach movement, out
- 6 Reach movement, in

Only the opening point (S) on the valves needs to be calibrated.

"E" stands for the closing point of the valve; this does not need calibrating. To perform calibration, select the desired valve in the table above.

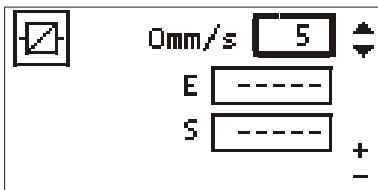
Free lift and main lift valve calibration

1. Select valve 1.
2. Start by entering a value in the "S" box: 100 mA.
3. Lift the forks using the lever as usual. The forks should now slowly move upwards. If the forks do not move, increase the value in the "S" box, by 25 mA at a time, until the forks start to move.
4. At approximately 0.5–1 second intervals, press the minus button until the forks halt.
5. Calibration 1 (free lift) is now complete. Repeat on valve 3 (main lift).

Free lowering and main lowering valve calibration

1. Select valve 2.
2. This calibration should be performed with a load (at least 500 kg) on the forks.
3. Start by entering a value in the "S" box: 100 mA.
4. Lower the forks using the lever as usual. The forks should now slowly move downwards. If the forks do not move, increase the value in the "S" box, by 25 mA at a time, until the forks start to move.
5. At approximately 0.5–1 second intervals, press the minus button until the forks have very low constant speed (obtained by the pilot valve).
6. Calibration 2 (free lowering) is now complete. Repeat on valve 4 (main lowering).

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Reach movement valve calibration

1. Select valve 5, reach movement valve in the OUT direction.
2. Start by retracting the mast to its home position.
3. Enter 100 mA in the "S" box.
4. Extend the mast using the lever as usual. The reach carriage should now slowly move out.
5. If the reach carriage does not move, increase the value in the "S" box, by 25 mA at a time, until it starts to move on its own.
6. At approximately 0.5–1 second intervals, press the minus button until the reach carriage halts.
7. Calibration of valve 5 is complete.
8. Select valve 6, reach movement valve in the IN direction.
9. Start by running out the mast to its furthest position.
10. Enter 100 mA in the "S" box.
11. Retract the mast using the lever as usual. The reach carriage should now slowly move in.
12. If the reach carriage does not move, increase the value in the "S" box, by 25 mA at a time, until it starts to move on its own.
13. At approximately 0.5–1 second intervals, press the minus button until the reach carriage halts.
14. Calibration of valve 6 is complete.

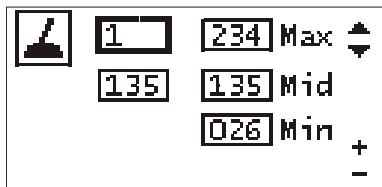
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13.4.2 Joystick calibration

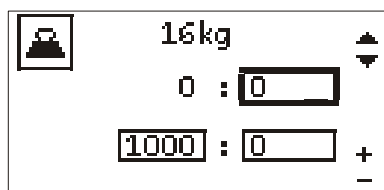


1. Use the arrow keys to select the top left box. Change the value with +/- keys to correspond to the joystick to be calibrated.
2. Move the selection down, with the arrow keys, to the bottom left box.
3. Move the joystick to its maximum position and press the green key. The CID detects the value and stores it as "Max".
4. Release the joystick to its neutral position and press the green key.
5. Move the joystick to its minimum position and press the green key.

Repeat steps 1 to 5 for other joysticks that have to be calibrated.

13.4.3 Weight calibration

The weight mode is used to calibrate the fork load indicator.



Calibrating the weight indicator

1. Lower the unladen forks to the floor.
2. Lift them at full speed to about 1 metre above the ground.
3. Wait for about 1 minute.
4. Using the arrow keys, select the box on the right .
5. Read off the weight on the CID screen (in the middle at the top). Use the plus/minus buttons to adjust the read value to 0 (± 5 kg).
6. Take a load of known weight (over 500 kg) on the forks.
7. Change the value "1000" in the bottom left-hand box to the known weight of the load.
8. Lower the forks to the floor and lift them at full speed to 1 metre above the ground.
9. Wait for about 1 minute.
10. Select the box on the bottom right.
11. Read off the weight on the CID screen. Use the plus/minus buttons to adjust the read value to the known weight of the load (± 5 kg).

Repeat steps 1 to 8 as necessary.

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13.4.4 Height measurement/reach movement length calibration

Calibrating height measurement (option)

Reference sensor, free lift

1. From the operator compartment, have a look down into the fork carriage on the inside of the mast. You will now be able to see the free lift reference sensor, located ~0.8 m above the floor.
2. Locate the forks so that they are approximately 0.1 m under the sensor. The forks must be horizontal to the floor, i.e., not tilted.
3. Select screen 1 (if you have made the selection before, the speed will be low on lifting).
4. Lift the forks; they will stop exactly at the sensor.
5. Measure the height manually on the forks, nearest to the mast. Re-measure at the fork tips.
6. Enter the measured value (unit is mm) along the bottom in the box on the screen and press the green button (I).

Reference sensor, main lift

1. Continue to screen 2. If you are on screen 1, this is done by being in the top box and pressing the plus button. Confirm using the green button (I).
2. This is where you can calibrate the main lift reference sensor.
3. Lift the main mast about 0.1 m.
4. Lower the main mast to its "rest position".
5. Using the arrow keys, select the box along the bottom of the screen and press the green button (I). The correct value is read and saved automatically.

Max. free lift height

1. Continue to screen 3. If you are on screen 2, you do this by moving the cursor to the top box and pressing the plus button. Confirm using the green button (I).
2. This is where you can calibrate free lift height.
3. Lift the forks until they halt; they will do this at max. free lift height.
4. Using the arrow keys, select the box along the bottom of the screen and press the green button (I). The correct value is read and saved automatically.

Electrical system 5000

Calibrations

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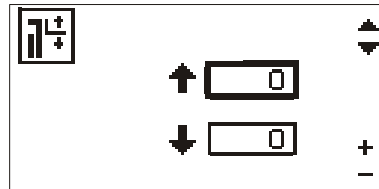
Calibrating reach movement length

1. Go to screen 4 (scroll with the plus/minus buttons and confirm with the green button).
2. This is where you can calibrate reach movement length; this gives more gentle braking in the end position.
3. Start by calibrating "zero"; this is done by retracting the mast to the home position, releasing the lever and taking hold of it again within 1 second.
4. Hold the control until zeroing is complete. The length that is visible at the top of the screen in the middle is changed to zero, and a pip confirms that calibration is complete.
5. Run out the mast until it stops (mechanical stop).
6. Using the arrow keys, select the box along the bottom of the screen and press the green button (I). The correct value is read and saved automatically.

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13.4.5 Transition/mast separation calibration

This should be performed after height measurement calibration if height measurement (option) is available.



The top box gives the flow on transition from free lift to main lift, in order to obtain smooth transition between free lift and main lift.

The bottom box gives the flow on downward transition. The units are in %, with a minimum value of 15 and a maximum of 60.

1. Start by lifting the forks at full speed from free lift to main lift.
2. If transition is not felt to be smooth enough, reduce the value in the top box using the plus/minus buttons (numerical buttons are not supported).
3. If the forks do not reach "free lift top" within a reasonable time (several metres into main lift), raise the value.
4. Repeat stages 1–3 until the upward transition is satisfactory.
5. Lower the forks at full speed from main lift to free lift.
6. If main lift hits the "bottom" too hard, reduce the value in the bottom box.
7. If the forks do not reach "main lift bottom" within a reasonable time (several metres into main lift), raise the value.
8. Repeat stages 5–7 until the downward transition is satisfactory.

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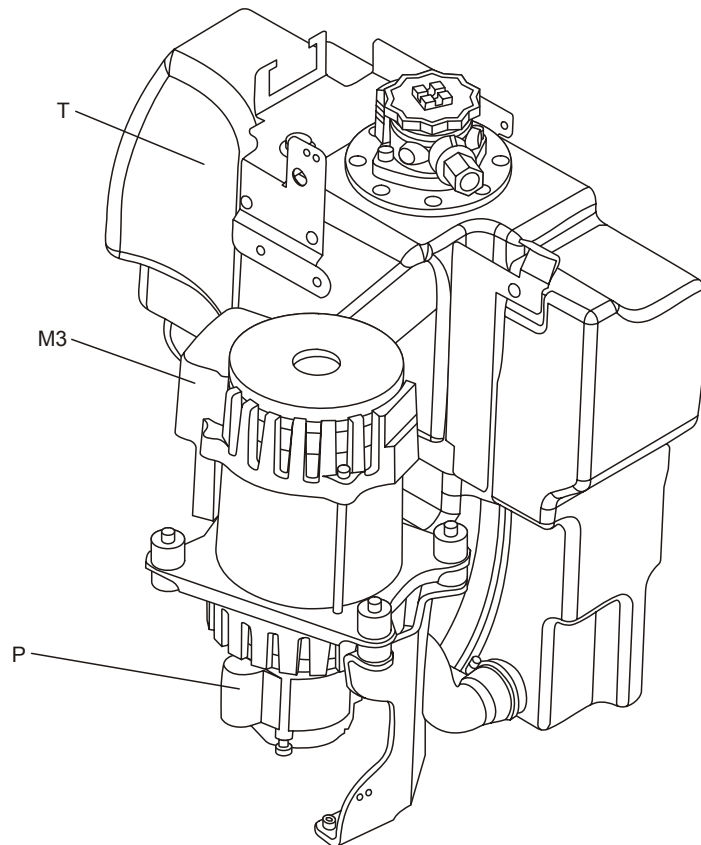
Calibrations

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14 – Hydraulic system 6000

14.1 Hydraulic unit (6100)



Item	Function
T	Tank
M3	Pump motor
P	Pump

Hydraulic system 6000

Hydraulic unit (6100)

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14.1.1 Hydraulic tank, draining

Method a (recommended):

1. Release the pressure hose for extra hydraulic functions, located beside the mast.
2. Use a bucket or similar to collect the oil.
3. Activate the extra function by the means of the corresponding control lever pushed to lowest possible flow.

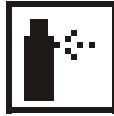
The oil must not be reused and shall be sent for destruction according to normal procedures.

Method b:

Use suitable pump to drain the tank.

The oil must not be reused and shall be sent for destruction according to normal procedures.

14.1.2 Hydraulic system, bleeding



1. Put the truck program in service mode and activate the service position for bleeding. The bleeding position initiates pump motor start-up and simultaneous opening of both the lift and the lowering valves. The pressure in the valve block will reach around 1 MPa (10 bar).
2. Open the bleed nipple on the main lift cylinder approximately 2 turns. If the bleed nipple cannot be reached from the operator compartment, use a ladder or similar item leant up against the mast.
3. Once all the air has been removed from the cylinder, oil begins to drip out.
After 4 – 5 drops the bleed nipple must be closed.
4. Repeat bleeding on the other main lift cylinder.
5. Quit the truck program's service position for bleeding.
6. Activate the service position for separate operation of free lift and main lift.
7. Operate free lift (**NOTE! NOT** main lift) between maximum height and the fully lowered position 3 – 4 times to drain the air in the free lift cylinder into the tank. End with the mast in its fully lowered position.
8. Quit the truck program's service mode.
9. Check the oil level in the tank and top up as necessary to the right level.

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Hydraulic unit (6100)

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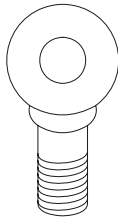
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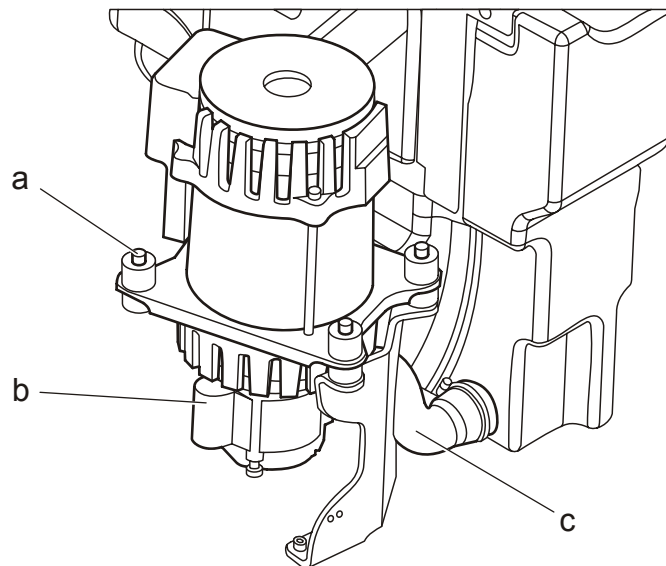
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14.1.3 Removing the pump motor from the truck

1. Lower the forks to their lowest position to reduce pressure in the hoses and pump.
2. Disconnect the battery connector.
3. Drain the hydraulic tank from oil, see "14.1.1 Hydraulic tank, draining" on page 14 – 2.
4. Remove the power cables from the pump motor.
5. Undo the temperature and speed gauge contacts on the motor.
6. Remove the pressure hose (b) from the pump (quick change connector) and undo the suction hose (c) (hose clips) from the pump.
7. Fasten a lifting eye to the motor shaft
8. Remove the screws (a) (6 mm allen screws) that hold the pump motor mounting to the chassis.



Mom 7: M12×1,75

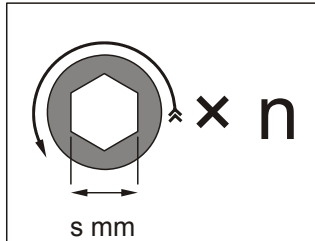


9. Lift out the hydraulic motor with the hydraulic pump and place it on a clean surface.

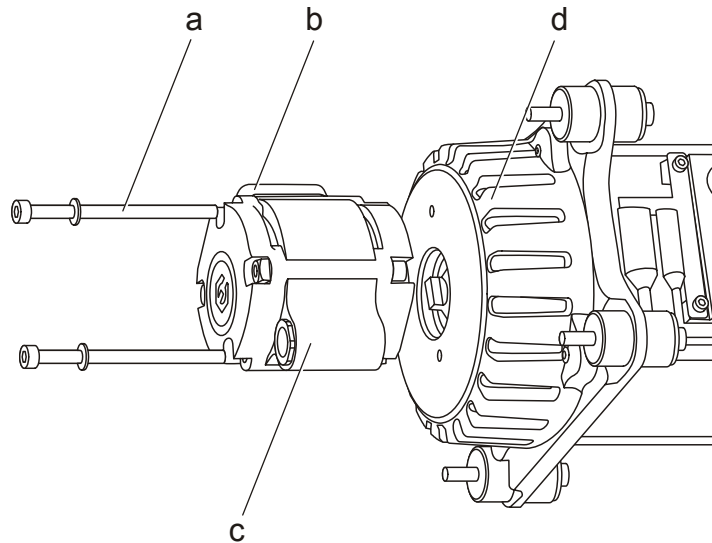
14.1.4 Replacing the hydraulic pump

For removal of the pump motor from the truck, See section "14.1.3 Removing the pump motor from the truck".

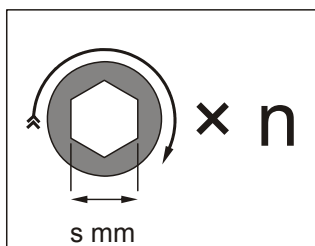
1. Remove the suction connection (b) from the pump.
2. Remove the two screws (a) (6 mm allen screws).
3. Separate the hydraulic pump (c) from the motor (d).



Mom 2: $s = 6$, $n = 2$



4. Place the suction connection on the new pump unit.
5. Place a new O-ring on the pump between the pump and pump motor.
6. Place the pump unit on the pump motor.
7. Tighten the screws.

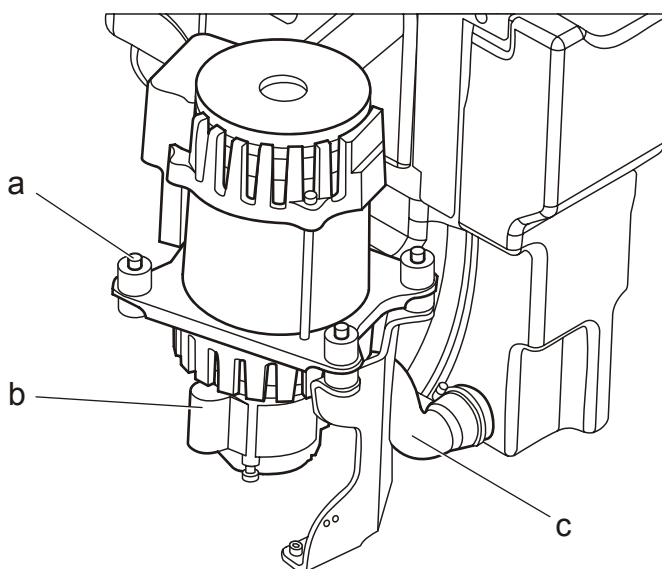


Mom 7: $s = 6$, $n = 2$

$23 \pm 6 \text{ Nm}$

14.1.5 Fitting the pump motor in the truck

1. Screw a lifting eye into the end of the motor shaft and connect it to a traverse if necessary.
2. Lift the hydraulic pump into the truck and at the same time run the hydraulic hose (c) from the tank to the pump.
3. Tighten the hose clamp.
4. Tighten the screws (a) (6 mm allen screws) that hold the pump motor mounting.
5. Unscrew the lifting eye.
6. Replace the hydraulic hose (b) in the quick change connector.



7. Connect the temperature and speed gauge contacts and the power cables.
8. Check the oil level and if necessary top up the hydraulic oil in the tank.
9. Before any hydraulic function is initiated:



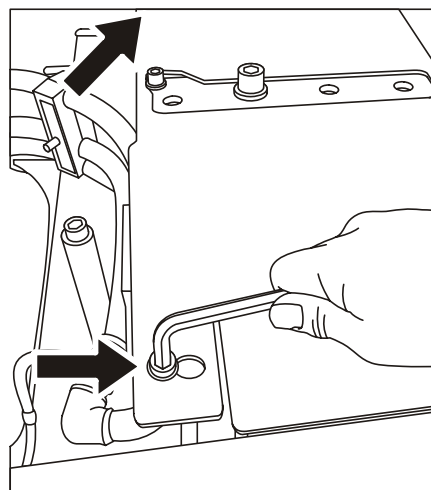
Put the truck program in service mode and activate the service position for bleeding.

14.2 Main valve (6210)

14.2.1 Emergency lowering of forks

On the top of the valve block is an emergency lowering valve for the mast. Both the main lift cylinders and the free lift cylinder are connected to the emergency lowering valve.

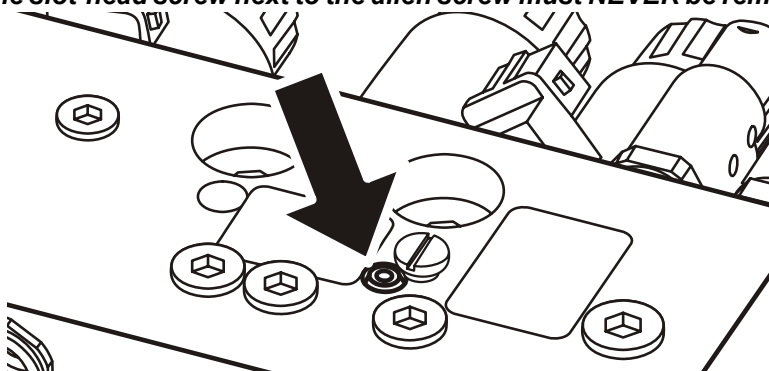
1. Extend the reach carriage fully.
2. Switch off the truck and withdraw the battery cut out connector.
3. Undo the two screws (8 mm allen screws) that hold the protective plate over the main valve in the reach carriage, and remove the plate.



4. Open the emergency lowering valve (arrow) (3 mm allen screw). The screw only needs opening 1½ turns to lower the forks.

IMPORTANT!

The slot-head screw next to the allen screw must NEVER be removed.



5. Once lowering is complete, tighten the screw to 2.5 Nm only.

Hydraulic system 6000

Main valve (6210)

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14.2.2 Replacing the complete main valve block

The main valve block contains:

- Proportional slide valves that are individually matched and cannot be replaced
- Proportional valves of replaceable cartridge design

Valve	Function	Type
Q2	Main lift – lift	Replaceable cartridge
Q3	Free lift – lift	Replaceable cartridge
Q4	Main lift – lower	Replaceable cartridge
Q5	Free lift – lower	Replaceable cartridge
Q6	Reach in	Non-replaceable slide
Q7	Reach out	Non-replaceable slide
Q11	Ergo: Cabin tilt – up	Non-replaceable slide
Q21	Ergo: Cabin tilt – down	Non-replaceable slide

In the event of defects in the non-replaceable valves, the entire main valve block must be replaced.

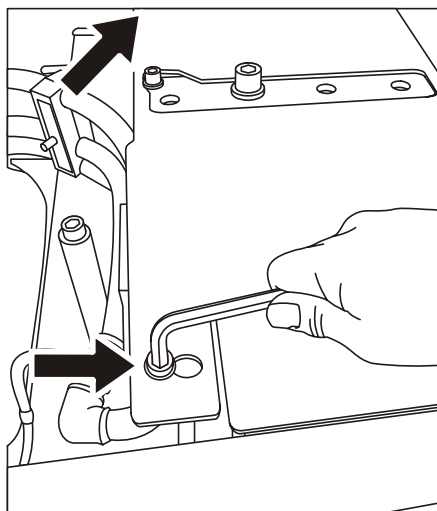
IMPORTANT:

On delivery of a complete main valve block, it is adjusted for a 2.0 ton mast.

For trucks with 2.0 ton masts, only calibration of opening points of Q4/Q5 is normally required.

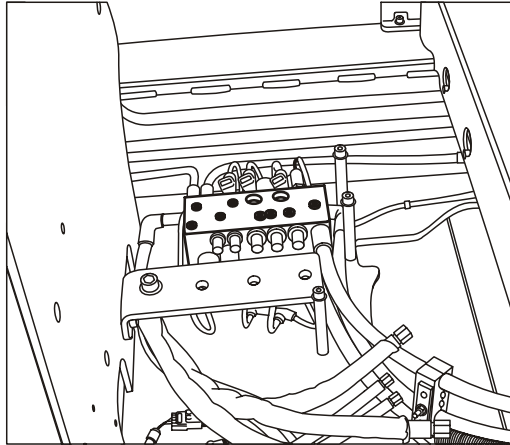
For other masts, both calibration of opening points and adjustment of maximum opening points are required.

1. Extend the reach carriage fully.
2. Make sure the forks are in their bottom position and that there is no load affecting the mast.
3. Put the truck in service mode and go to pressure equalisation position in the service menu. All the valves are opened slightly and any residual pressure in the system is equalised.
4. Switch off the truck and withdraw the battery cut out connector.
5. Undo the two screws (8 mm allen screws) that hold the protective plate over the main valve in the reach carriage, and remove the plate.
6. Remove all the hoses from the main valve. Mark them to facilitate assembly.



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7. Place protective plugs on all hoses and the main valve.
8. Disconnect all cables from the main valve, (check that their markings are legible).



9. Undo the two screws (6 mm allen screws) that hold the valve in place in the reach carriage, and remove the main valve.
10. Reassemble in reverse order.



11. Before any hydraulic function is initiated:
12. Put the truck program in service mode and activate the service position for bleeding.

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14.2.3 Adjustment of maximum opening point

When any of the proportional valves Q4 or Q5 are replaced, calibration and adjustment are required. As in the calibration case, the forks shall have a load of >500 kg.

The correct lowering motion shall be 0.53 m/s at an oil temperature of 20° C.

1. Calibrate the valve, see “ Free lowering and main lowering valve calibration” on page 13 – 14.
2. Lift the forks >2 m within the desired function's, free lift/main lift, action heights.
3. Use a measuring tape to read the exact fork height.
4. Lower the forks, by the means of fork lift/lower control lever in maximum lower position, for 2 seconds.
5. Measure the ending fork height. For 2 seconds of lowering, the forks shall be lowered 1.06 m.
6. If the motion differs from 1.06 m, adjustment is necessary:
Release the locking nut by the means of a 10 mm key.
Use a 3 mm hex-Allen key to change the valve setting:
 - CW decreases the lowering speed.
 - CCW increases the lowering speed.
7. Tighten the locking nut and repeat the procedure until correct motion is reached.

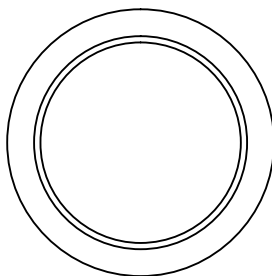
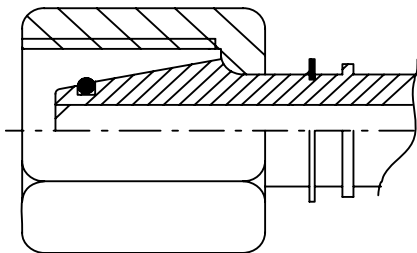
14.3 Hydraulic connections (6230)

Item	Function
M	Pressure sensor connection
M2	Pressure sensor connection
MP	Pump pressure measuring
P	Pump
T	Tank

14.3.1 Tightening torque for hydraulic connections

Conical connection with O-ring

The nut is screwed down by hand until it stops and is then tightened, either to a given torque, or to the number of degrees specified in the table below. These are generally used on the majority of hydraulic hoses on the trucks.



Dimension \varnothing [mm]	Tightening torque [Nm]	Tightening angle [°]
6	23	30-45
10	30	30-45
12	50	30-45
15	60	30-45
18	70	30-45
20	80	30-45

Tredo seal

The nut/connection is screwed down by hand until it stops and is then tightened to a given torque as specified in the table below.

Dimension	Tightening torque [Nm]
R 1/8	12-18
R 1/4	25-45
R 3/8	50-70
R 1/2	70-100
R 5/8	100-140
R 3/4	150-200

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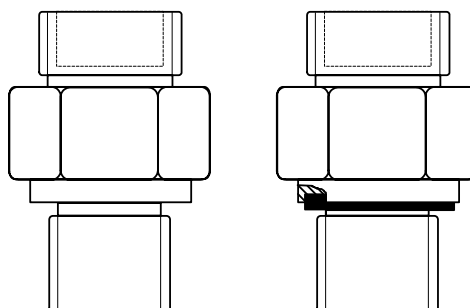
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Dimension	Tightening torque [Nm]
R 1	195-250
R 1 1/4	250-310
R 1 1/2	310-400
M 18	50-70
M 22	100-140
M 26	150-200

Pipe coupling



Tighten the coupling by hand and then tighten one half turn to obtain the correct torque.

Coupling screwed into aluminium

Designation with biting edge	Dimension	Torque [Nm]
G 1/8	R 1/8	~7
G 1/4	R 1/4	~12
G 3/8	R 3/8	~20
G 1/2	R 1/2	~30
G 3/4	R 3/4	~80
G 1	R 1	~100

Coupling screwed into steel

Pressure class L

Designation with biting edge	Dimension	Torque [Nm]	Designation with EOLASTIC sealing ring	Dimension	Torque [Nm]
GE 6-LM	M 10x1	~20	GE 6-LM-ed	M 10x1	~10
GE 6-LR	R 1/8	~20	GE 6-LR-ed	R 1/8	~10
GE 8-LM	M 12x1.5	~29	GE 8-LM-ed	M 12x1.5	~20
GE 8-LR	R 1/4	~39	GE 8-LR-ed	R 1/4	~20

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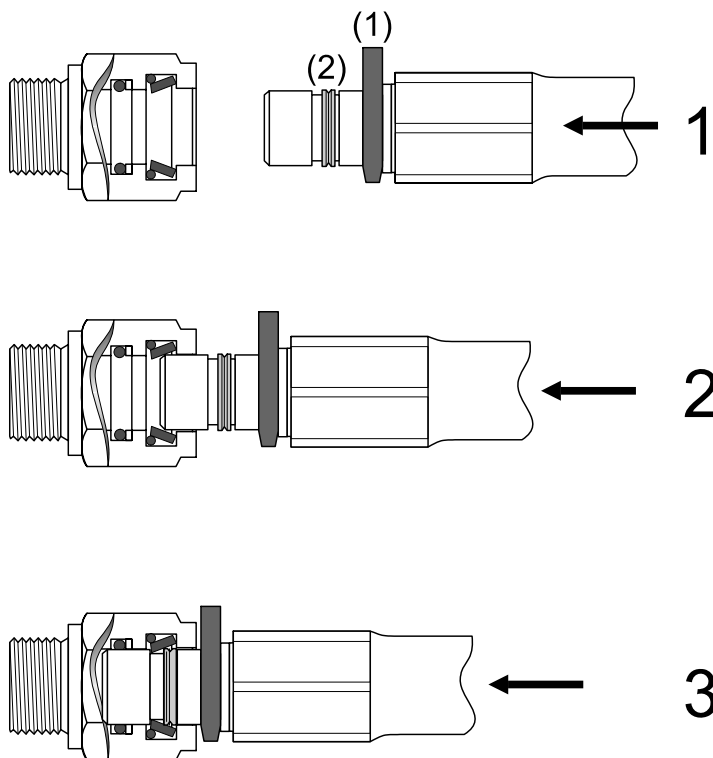
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Designation with biting edge	Dimension	Torque [Nm]	Designation with EOLASTIC sealing ring	Dimension	Torque [Nm]
GE 10-LM	M 14x1.5	~39	GE 10-LM-ed	M 14x1.5	~29
GE 10-LR	R 1/4	~39	GE 10-LR-ed	R 1/4	~20
GE 12-LM	M 16x1.5	~59	GE 12-LM-ed	M 16x1.5	~29
GE 12-LR	R 3/8	~59	GE 12-LR-ed	R 3/8	~39
GE 15-LM	M 18x1.5	~69	GE 15-LM-ed	M 18x1.5	~39
GE 15-LR	R 1/2	~108	GE 15-LR-ed	R 1/2	~59
GE 18-LM	M 22x1.5	~108	GE 18-LM-ed	M 18x1.5	~59
GE 18-LR	R 1/2	~108	GE 18-LR-ed	R 1/2	~59
GE 22-LM	M 26x1.5	~128	GE 22-LM-ed	M 22x1.5	~69
GE 22-LR	R 3/4	~157	GE 22-LR-ed	R 3/4	~88
GE 28-LM	M 33x2	~216	GE 28-LM-ed	M 33x2	~118
GE 28-LR	R 1	~265	GE 28-LR-ed	M 33x2	~137
GE 35-LM	M 42x2	~353	GE 35-LM-ed	M 42x2	~196
GE 35-LR	R 1 1/4	~392	GE 35-LR-ed	R 1 1/4	~235
GE 42-LM	M 48x2	~491	GE 42-LM-ed	M 48x2	~294
GE 42-LR	R 1 1/2	~491	GE 42-LR-ed	R 1 1/2	~294

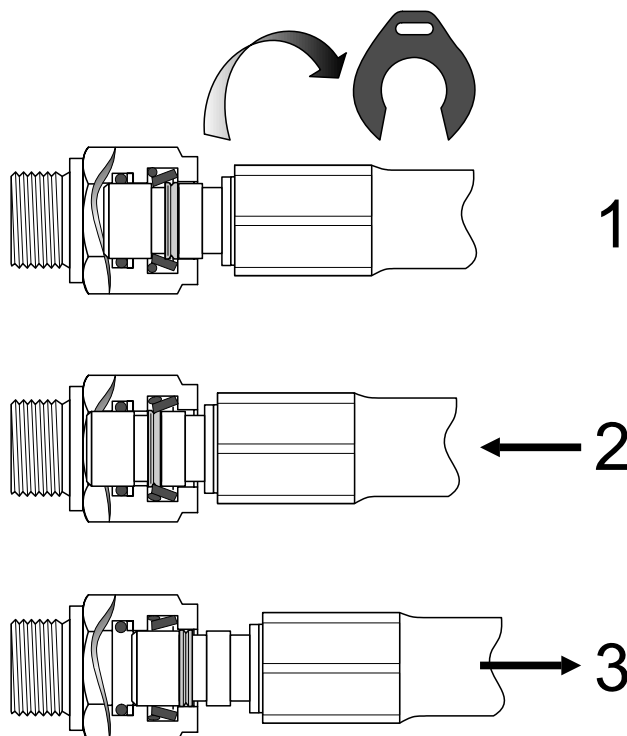
14.3.2 Quick change connector

Assembling the quick change connector



1. Place the assembly stop (1) on the male fitting and make sure that the dismantling ring (2) runs freely in the groove.
2. Push the male fitting into the female fitting until the assembly stop makes contact with the female fitting.
3. The coupling is now made and locked.

Dismantling the quick change connector



1. Remove the assembly stop (with the aid of a screwdriver or similar tool).
2. Push the male fitting all the way into the female fitting.
3. Pull the male fitting out of the female fitting.
4. Refit the assembly stop on the male fitting.
5. Place protective plugs on the valve and hose.

14.4 Hydraulic system, mast (6300)

14.4.1 Mast-mounted hose reel (6370)

General

These assembly instructions contain the information needed for trouble-free installation and operation. The enclosed operating instructions contain information relating to inspection and maintenance, as well as the instructions.

14.4.2 Fitting the hose reel

To preload the spring, the hose drum should be rotated in the direction of hose extraction, with the hose fully wound.

Preloading the hose drum:

- For extraction to the right, rotate the drum clockwise.
- For extraction to the left, rotate the drum anticlockwise.



DANGER!

Loaded spring.

The hose can cause injury.

Always exercise caution when working with the hose reel.

The number of turns depends on the length and diameter of the hose - see the table. The stated values apply as guideline values.

Spring preloading (turns)

Hose diameter (mm)	Hose length (m)						
	2.7	3	3.3	5	6	7	8.5
6.3	-	-	4	3	3	3	1.5-2
8	4	4	-	3	3	-	-

The hose is only pulled out from the drum once the correct preloading value has been reached.

14.4.3 Checks after fitting

When the hose reel is used for the first time, lift the forks carefully to the maximum lift height. Check that the hose and hose drum work correctly and count the number of turns that the hose drum rotates.

The total for the number of turns made by hand when preloading plus the number of turns for maximum extraction must not exceed 10.

Turns on preloading + turns in operation = 10 turns max.

IMPORTANT!

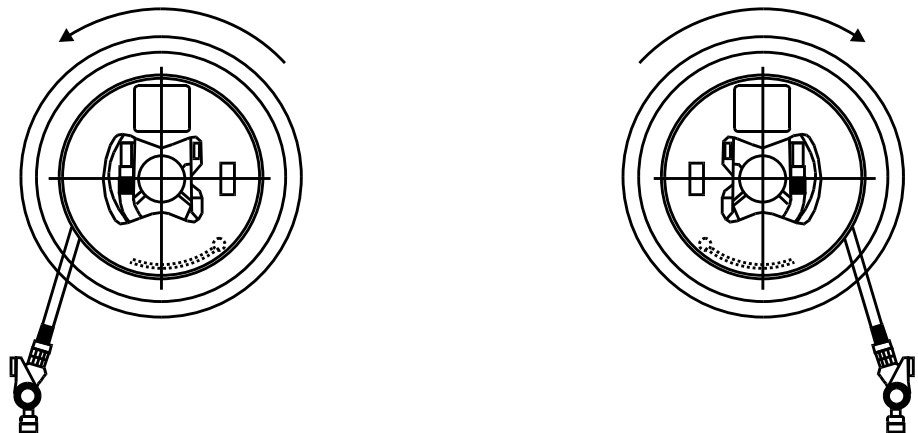
At maximum lift height, the hose must not be fully unwound from the hose drum. At least $\frac{1}{4}$ of a turn of hose must still remain on the hose drum.

Make sure that the hose drum can still be turned by hand with the hose fully extracted. The hose drum must not lock.

Check that the hose rewinds correctly when the forks are lowered. The hose must always be under tension, otherwise there is a risk of the hose sliding over the side plates. If this is the case, adjust the preloading tension.

IMPORTANT!

The spring-loaded eye must face the direction in which the hose unwinds.



Spare parts must conform to the technical specifications laid down by the manufacturer. This requirement is always met if original spare parts are used.

14.5 Main lift cylinder (6610)

General

The instructions below relate to the main lift cylinders in the mast. There are two main lift cylinders in the mast. The cylinders are of plunger type, i.e. they are piston-less cylinders.

In the cylinder's hydraulic hose quick change connector there is a hose rupture valve that prevents the forks from falling in the event of rupture to a hose.

We recommend that all masts, irrespective of lift height, be lifted of before the cylinders are removed.

14.5.1 Removing the air cylinder from the mast

1. From the top, loosen the lift chain next to the lift cylinder to be removed, and lay it out on the floor over the reach carriage.
2. Remove the lifting chain wheel.
3. Undo the lift cylinder from the top beam.
4. Use blocks to chock up both inner runners approximately 50 cm above the floor.
5. Lower the free lift cylinder to the bottom.
6. Undo the hydraulic hose from the lift cylinder and plug it.
7. Check that the lifting chain that still remains is not damaged.
8. Check that the lifting chain does not get damaged nor damage anything while you raise the mast to the top.
9. Undo the lift cylinder at its bottom stud.
10. Undo the cylinder support at the top.
11. Remove the cylinder from the mast.

14.5.2 Replacing the hose rupture valve

The hose rupture valve is integrated in the quick change connector for the hydraulic hose.

1. Remove the hydraulic hose from the quick change connector and plug it.
2. Unscrew the quick change connector from the cylinder.
3. Put a new quick change connector on.

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14.5.3 Fitting the cylinder to the mast

1. Lift the cylinder into the mast.
2. Fasten the cylinder onto the bottom stud.
3. Fit the cylinder support.
4. Using blocks, chock up the inner runner approximately 50 cm above the floor.
5. Lower the mast.
6. Connect the hydraulic hose to the cylinder.
7. Raise the forks until the lift cylinder makes contact with the top beam.
8. Fasten the cylinder to the top beam.
9. Lower the forks to the bottom.
10. Fit the chain wheel and lifting chain.
11. Adjust the chain so that the mast does not pull to one side at the top.

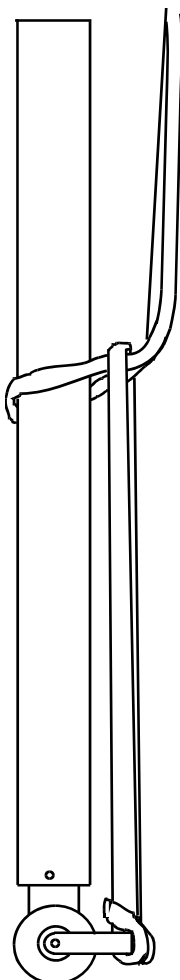
14.6 Free lift cylinder (6620)

General

The free lift cylinder is the cylinder located in the centre of the cylinders in the mast. The free lift cylinder is a single-action cylinder.

There is a hose rupture valve fitted in the free lift cylinder that prevents the load from falling in the event of rupture to a hose.

14.6.1 Removing the free lift cylinder from the truck

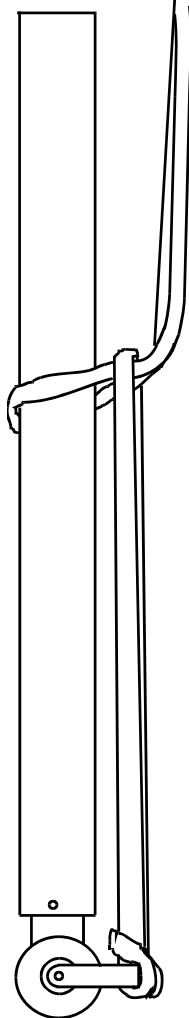


1. Remove the feeder pipe on the free lift cylinder.
2. Plug the free lift cylinder.
3. Loosen the mounting bolts on the top of the free lift cylinder.
4. Lift the intermediate runner using a traverse so that there is slack in the twin hose and cable.
5. Remove the twin hose and cable from the hose reels on the free lift cylinder.
6. Chock up under the fork yoke.
7. Lower the traverse so that the fork yoke rests on the block and there is slack in the free lifting chain.
8. Tie the chains together so that they do not slide out of the upper chain rollers.
9. Remove the inner split pin on the free lifting chain pin.
10. Remove the free lifting chain pin.
11. Lift the free lifting chain from the free lift cylinder.
12. Remove the chain adjuster from the free lift cylinder.
13. Secure a lifting strap around the free lifting chain bracket by the end of the free lift piston and a lifting strap around the free lift cylinder (see diagram).
14. Secure the lifting strap in a traverse.
15. Remove the mounting bolts on the top of the free lift cylinder.
16. Lower the free lift cylinder.

14.6.2 Replacing the hose rupture valve, free lift cylinder

The hose rupture valve (lowering brake valve) is fitted in the hydraulic cylinder's pipe connection and can be replaced using standard tools.

14.6.3 Placing the free lift cylinder in the truck



1. Secure a lifting strap around the free lifting chain bracket by the end of the free lift piston and a lifting strap around the free lift cylinder (see diagram).
2. Lift the free lift cylinder into its correct position.
3. Fit the free lift cylinder using its mounting bolts.
4. Take away the traverse.
5. Fit the chain adjuster.
6. Fit the free lifting chain with its pin.
7. Fit the split pin.
8. Remove the straps from around the free lifting chain.
9. Lift the inner guide using a traverse.
10. Place the twin hose and the cable on the free lift cylinder's hose reels.
11. Take away the traverse.
12. Remove the plugs on the free lift cylinder.
13. Fit the feeder pipe to the free lift cylinder.

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14.7 Reach cylinder (6650)

14.7.1 General

The reach cylinder is located in the reach carriage.

The reach cylinder is a double-acting cylinder.

The direction of the cylinder is governed by the main valve.

14.7.2 Removing the reach cylinder from the truck

1. Fully extend the mast.
2. Remove the battery cut out connector from the truck.
3. Remove the reach carriage graduated rule. This is attached at each end by snap fasteners and can be lifted out by gently tugging on it.
4. Remove the hoses from the reach cylinder and plug them.
5. Remove the locking rings from the cylinder pins.
6. Remove the reach cylinder.

14.7.3 Placing the reach cylinder in the truck

1. Fit the reach cylinder to the pins.
2. Put the locking rings in position on the pins.
3. Fit the hoses to the cylinder.
4. Fit the reach carriage graduated rule. This has a snap fastener at each end and is attached by gently pressing on it.

14.8 Fork tilt cylinder (6660)

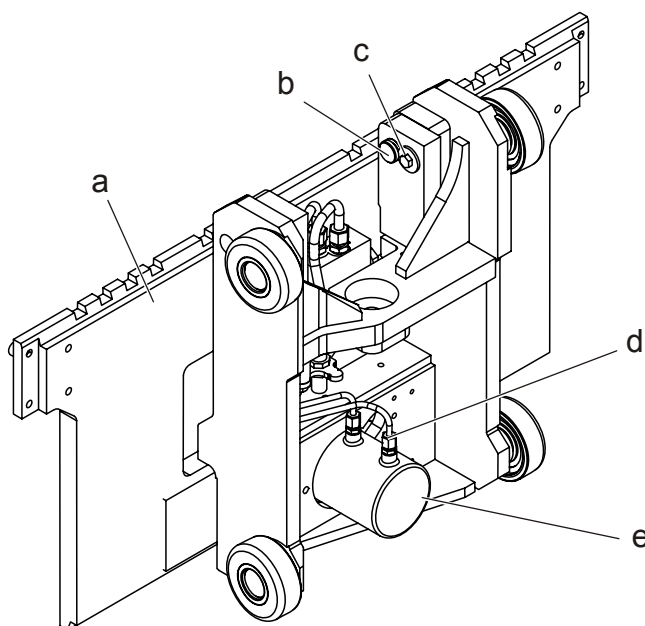
14.8.1 General

The fork tilt cylinder is located on the mast behind the lower edge of the fork yoke.

The cylinder is double-acting, which means it is the oil pressure that moves the piston backwards and forwards in the cylinder. When the piston is pressed out, the lower edge of the fork yoke is moved outwards, and, in doing so, the forks are tilted upwards.

14.8.2 Removing the tilt cylinder from the fork carriage

1. Lift the fork carriage to its correct working height.
2. Remove the forks.
3. Remove the screws and washers (c).
4. Secure a lifting strap around the fork yoke (a) and, using a traverse, take up the weight of the yoke.
5. Remove the axles (b) from the fork carriage.
6. Lift the fork yoke off.
7. Remove and plug the hydraulic lines to the tilt cylinder (e).
8. Remove the tilt cylinder (e).



9. Placing the tilt cylinder in the fork carriage
10. Refit in reverse order.

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Fork tilt cylinder (6660)

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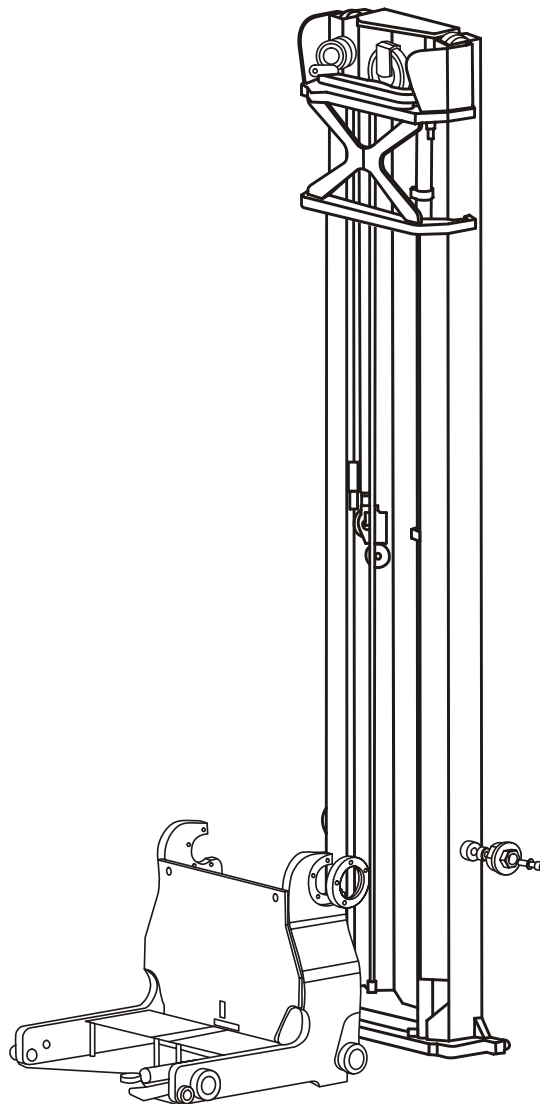
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15 – Mast/Lift system 7000

15.1 Main mast 1.6-2.5 t (7100)

15.1.1 Replacing the full mast

When ordering a replacement mast, TMHE Technical Support should be contacted to identify the mast.



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Main mast 1.6-2.5 t (7100)

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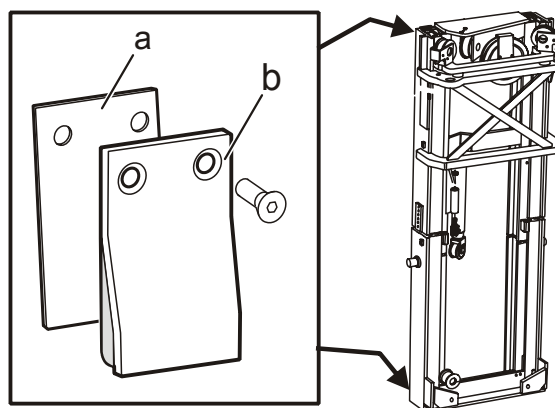
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15.1.2 Replacing the mast damper plates

If the mast emits a rattling sound on operation, this may be due to the damper plates at the bottom and top of the mast being worn.

1. Check the amount of play between the damper plate and mast.
2. Raise the mast approximately 2 dm from the floor.
3. Secure the mast with wooden blocks.
4. Remove the old plates at the bottom and top of the mast - see the diagram.
5. If the plate is not worn out, the play in relation to the mast can be adjusted using plate shims behind the plate. The shims are available in two thicknesses: 0.5 mm and 1 mm.



15.1.3 Removing the mast from the truck

1. Extend the reach carriage fully.
2. Set all hydraulic functions on the mast to the depressurised position, fork carriage fully lowered, tilt and side shift in the centre position.



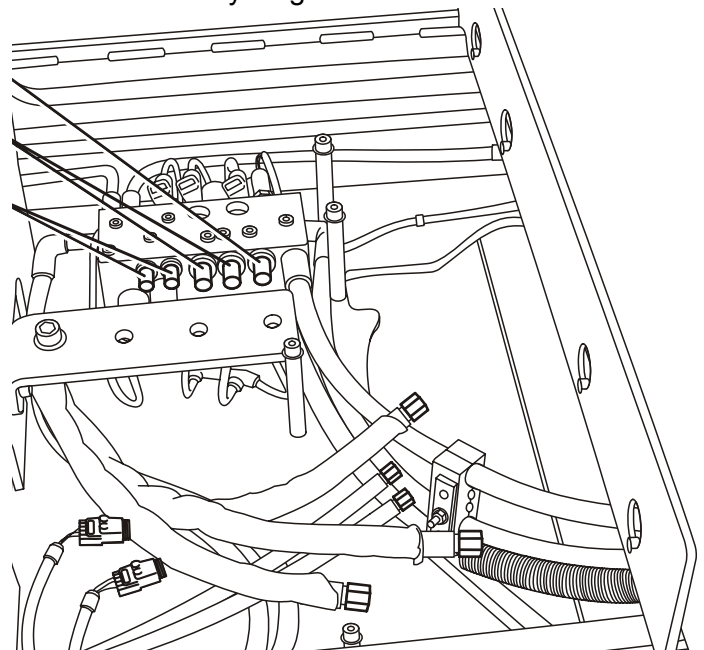
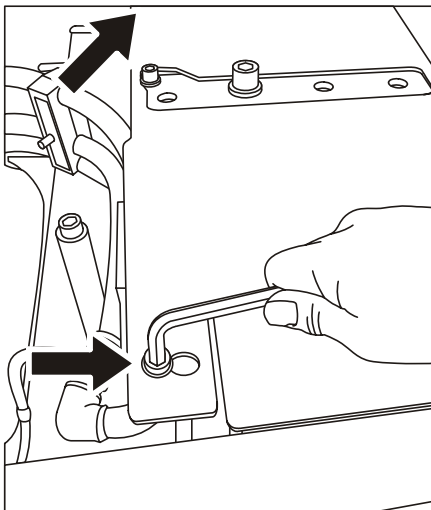
DANGER!

Risk of spurting oil.

Some parts of the hydraulic system may still retain residual pressure despite the system being depressurised.

Make sure there are no other persons in the vicinity of the truck and that you are standing to the side of the coupling you are about to disconnect.

3. Switch off the current and disconnect the battery by withdrawing the battery cut out connector.
4. Remove the forks and any load support.
5. Secure the mast using a traverse and lifting device (see the section "Tools").
6. Tie it up so that the weight of the mast is taken up by the traverse.
7. Undo the two screws (8 mm allen screws) that hold the protective plate over the main valve in the reach carriage, and remove the plate.
8. Remove the hoses for the tilt (A1, B1), main lift (H2, H3) and free lift cylinder (H1) from the main valve. Mark them to facilitate assembly.
9. Fit protective plugs on the main valve and hoses.
10. Disconnect any height indication and side shift cables.



11. If the truck is fitted with extra hydraulic functions, loosen the hydraulic hoses from the valve block on the reach carriage. Fit protective plugs on hoses and valve block.

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Main mast 1.6-2.5 t (7100)

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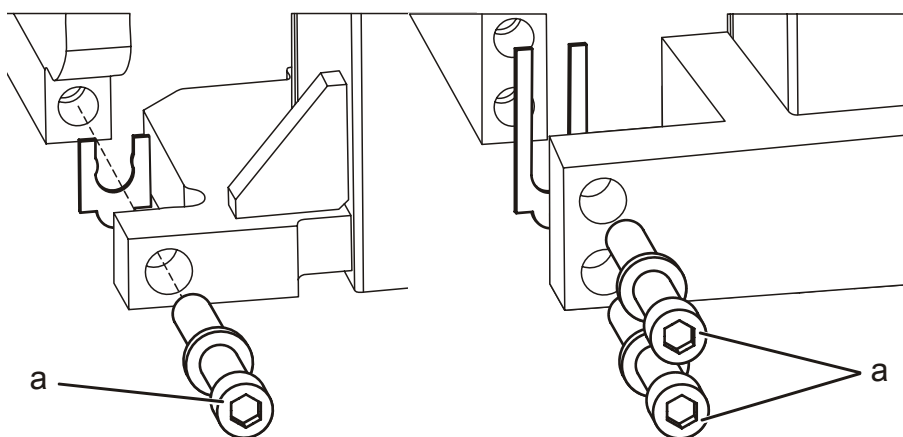
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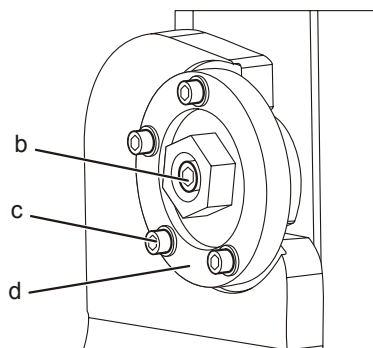
12. Undo and remove the screws (a) (19 mm allen screws) of the bottom attachment. The 2.5 ton mast has two screws, and other masts one screw per side.

IMPORTANT!

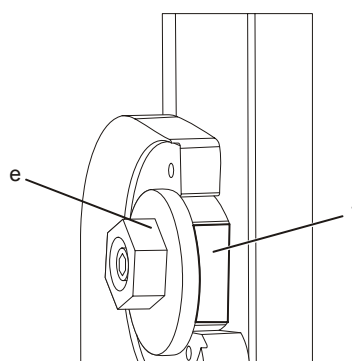
Mark the shims as being from the right or left respectively, so that the correct mast incline is obtained when refitting.



13. Undo the screws (b) (14 mm allen screws) approximately one turn.
14. Remove the screws (c) (10 mm allen screws) and the locking rings (d).



15. Mark (with a scribe or centre punch) the eccentric cam in relation to the reach carriage, to facilitate refitting and adjustment.
16. Turn the eccentric cams (e) (60 mm hexagonal screw) so that the large level surfaces (f) are facing downwards.

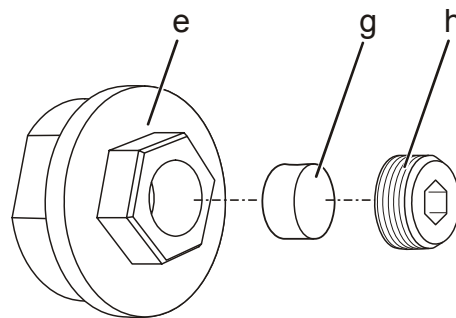


18. Lift out the mast.

If for any reason it should prove impossible to turn the eccentric cams (e), proceed as follows:

- Unscrew the adjusting screws (h).
- Plug the adjusting screw hole with a suitable spacer (g). This should be approximately 35 mm in diameter and approximately 20 mm in length. Now use the adjusting screw as a puller.

IMPORTANT! If there is no spacer, the adjusting screw will drop down into the eccentric cam once the thread runs out, and it will be impossible to get it to rethread.



19. Carefully lower the mast to the floor.

20. Place the mast on a pallet on the floor or, for a more comfortable working height, on a pair of trestles.



DANGER!

Unexpected/uncontrolled movement.

When the mast is laid down, shifting of the centre of gravity may cause the mast to slide to the floor.

Ensure no one is within the area in which the mast may move: mast length + 2 metres safety distance. Always stand to the side of the mast at a safe distance, as far away as the controls of the traverse will allow.

21. Wipe or wash off any oil spillage on the truck.

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Main mast 1.6-2.5 t (7100)

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15.1.4 Adjusting mast play

General

The mast rollers are fitted on angled pins that can be adjusted when mast play becomes excessive.

Lateral play is adjusted with shims, and radial play is adjusted using oversized rollers. Oversized rollers are available in increments of 0.4 mm.

Preparations

1. Remove the mast from the truck. See the section "Removing the mast from the truck".

IMPORTANT!

Leaking oil.

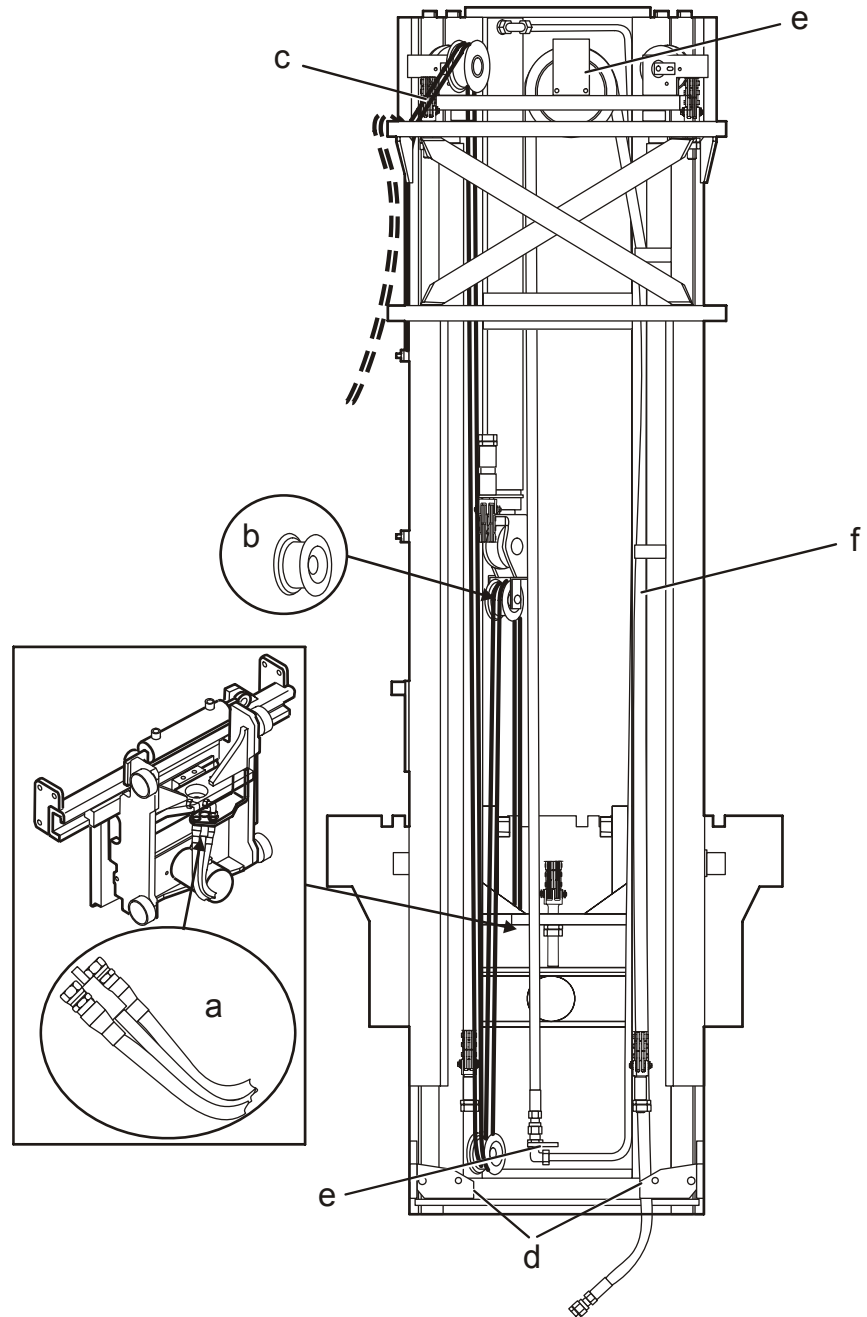
Risk of valve or cylinder failure if dirt enters the hydraulic connections.

Plug all hydraulic connections.

2. Place the mast horizontally on a number of pallets or similar items.

3. Remove:

- The twin hose (a) and connector units from the fork carriage.
- The twin hose reel (b) from the free lift cylinder.
- The twin hose (c) from the mast, but leave it in the outer runner.
- The feeder hoses (d) for the main lift cylinders.
- The feeder hose brackets (e) and the hose (f) for the free lift cylinder from the inner runner.



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Main mast 1.6-2.5 t (7100)

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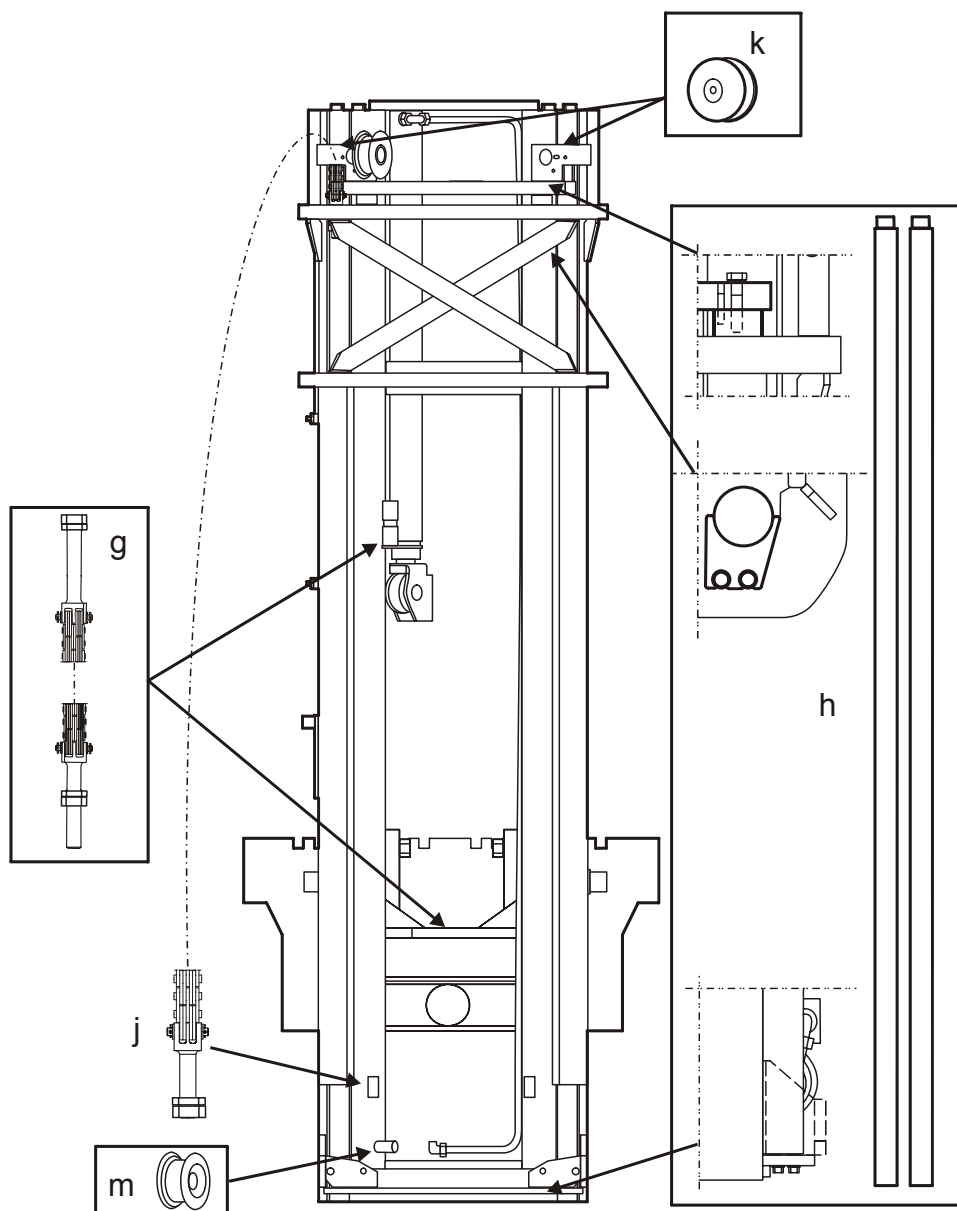
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4. Remove:

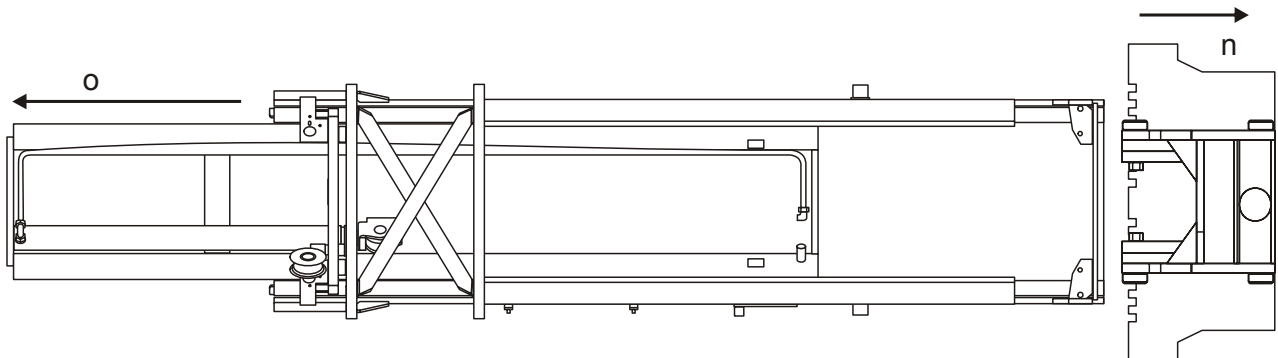
- The free lift chain (g) from the fork carriage and the free lift cylinder.
- The main lift cylinders (h).
- The main lift chains (j), but leave them in the outer runner.
- The main chain rollers (k) and the twin hose reel (m) at the bottom of the mast.



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5. Remove:

- The fork carriage (n) from the mast.
- The inner runner (o) from the mast using the BT lifting yoke (see the section "Tools").
- Pull out the inner runner to its full travel length and lift out the runner.



6. Clean the mast's component runners and rollers as well as the fork carriage rollers.

Adjusting lateral play

By shimming the mast rollers, lateral mast play can be adjusted.

IMPORTANT!

- Maximum play at the bottom (with mast retracted) is 1 mm.
 - Maximum play at the top end of the mast is 0.4 mm (both with mast retracted and mast extended).
1. Remove the runner from the mast.
 2. Remove the rollers that need to be shimmed.
 3. Fit:
 - The shims on the roller pins.
 - The rollers.
 - The runner on the mast.
 4. Measure and check. Use an indicator gauge and a crowbar to measure play. Measure the retracted and extended mast.
 5. Secure the intermediate and outer runners next to each other.
 6. Fit the inner runner to the mast.
 7. Measure and shim as specified in the instructions above.
 8. Fit the fork carriage to the mast.
 9. Measure and shim as specified in the instructions above.

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Main mast 1.6-2.5 t (7100)

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Adjustment of radial play

The play between roller and contact surface on the relevant beam must not exceed 0.4 mm. Check using a feeler gauge. If there is more play than this, the rollers must be replaced with oversized rollers. Oversized rollers (rated) are available in increments of 0.4 mm.

When fitting oversized rollers, play may be < 0 , provided that the mast can be pushed together/drawn apart by hand, even if this proves difficult to do. After a short period of use, the rollers will show an imprint of the contact surface, meaning that play is > 0 .

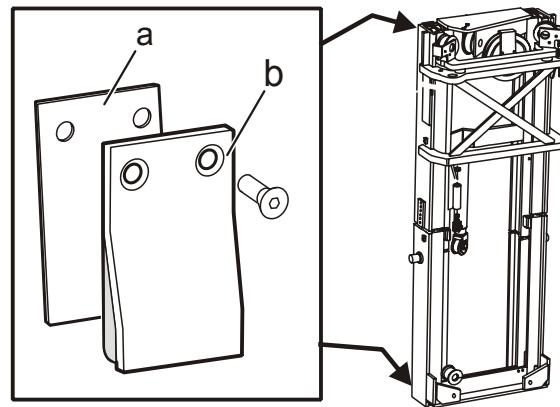
Adjusting the damper parts

The end position dampers are adjusted using washers so that the damper stops the runners simultaneously on both sides, and the ends of the beams are level at the end position - see the diagram.

Adjusting the damper plate

If the mast emits a rattling sound on operation, this may be due to the damper plates at the bottom and top of the mast being worn.

1. Check the amount of play between the damper plate and mast.
2. Pull the mast apart by approximately 2 dm.
3. Remove the old plates at the bottom and top of the mast - see the diagram.
4. If the plate is not worn out, the play in relation to the mast can be adjusted using plate shims behind the plate. The shims are available in two thicknesses: 0.5 mm and 1 mm.



Refitting the mast

1. Fit:
 - Free lift chain.
 - The chain guard, if present.
 - The main lift cylinders.
 - The main lift chain rollers.
 - The main lift chains.
 - Twin hose, cable and contacts in the fork carriage.
 - Twin hose reel to the free lift cylinder.
 - Manifold block with feeder hose to the main lift cylinders' feeder pipes.
 - Feeder hose bracket on the inner guide.

IMPORTANT!

The twin hose is liable to separate.

Risk of the twin hose breaking.

Make sure the twin hose rollers are in line.

Fit the mast to the truck - see the section "Placing the mast on the truck".

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Main mast 1.6-2.5 t (7100)

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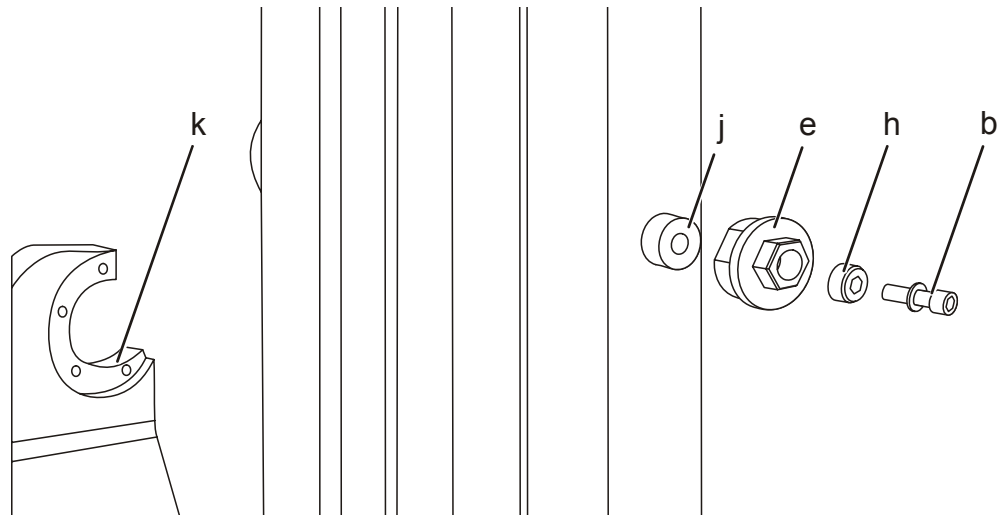
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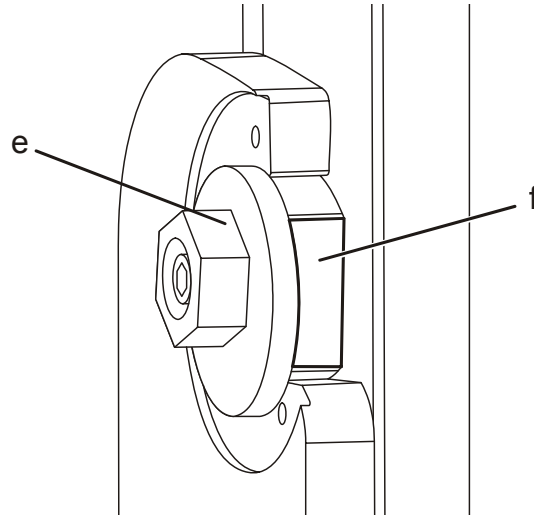
15.1.5 Placing the mast on the truck

1. Attach a lifting device (see the "Tools" section) to the mast and put the mast in an erect position, suspended in the traverse.
2. If the eccentric cams (e) have been removed from the mast or are new:
 - Lubricate the mast pin (j) with MoS2 grease.
 - Thread the eccentric cam (e) onto the pin (j).
 - Lubricate the threaded hole in the eccentric cam (e) and screw in the adjusting screw (h).
 - Screw in the locking screw (b) by hand to stop the eccentric cam falling off during the docking operation.

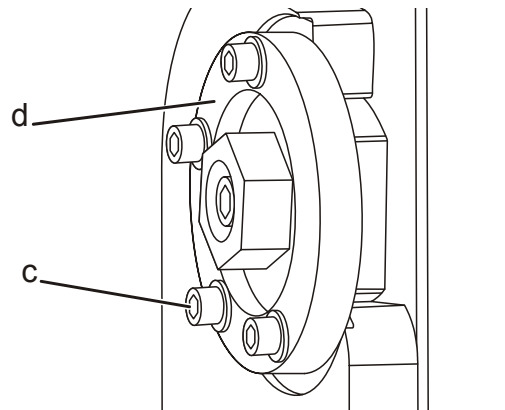


3. Turn the eccentric cams (e) so that the largest level surfaces attain a horizontal position facing downwards.
4. Lubricate the cups on the mast attachment (k) in the reach carriage with MoS2 grease.

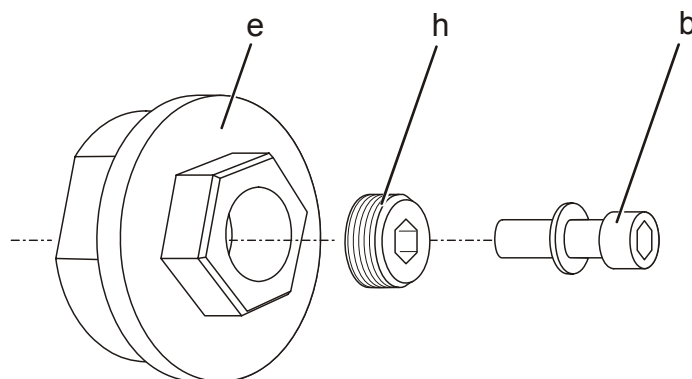
5. Dock the mast and turn the eccentric cams (e) through 90 degrees so that their largest level surfaces (f) attain the vertical and face outwards (towards the forks). Observe any previous marking made on the eccentric cam.



6. Screw the locking rings (d) in place with the screws (c) and their washers, so that the eccentric cams cannot turn.



7. If necessary, the mast and reach carriage are centred using the adjusting screws (h) by alternately moving the adjusting screw on one side and loosening on the other. Refit the locking screw (b).



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Main mast 1.6-2.5 t (7100)

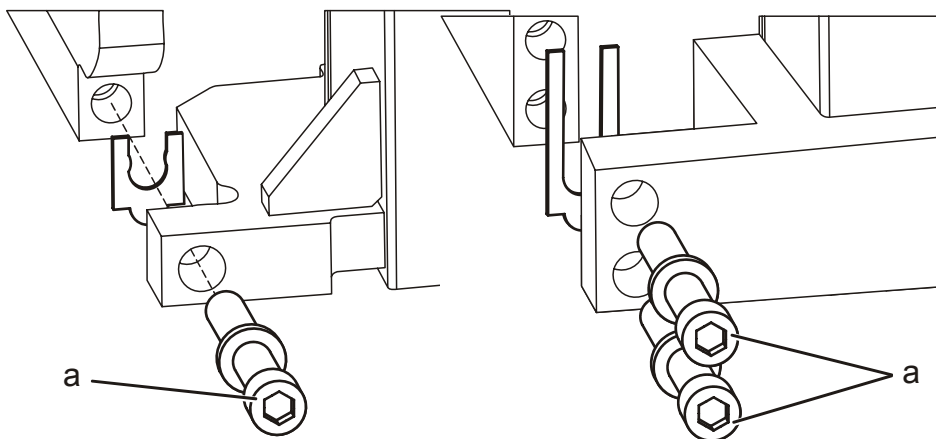
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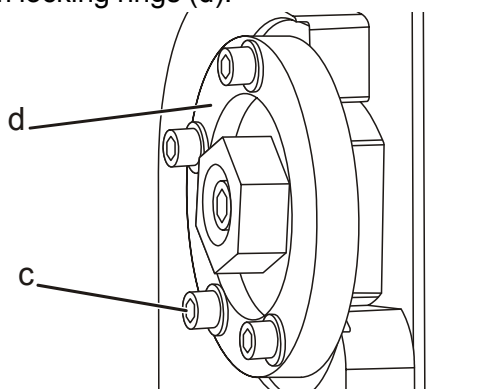
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8. Screw in the screws (a) and their washers into the bottom bracket.
9. Measure the incline to the rear and shim as needed. This should nominally be 2 shims, or $90^\circ \pm 10'$.



10. Engage the screws (a), but do not use a torque wrench to tighten them.
11. Adjust the lateral incline by loosening the screws (c) on the eccentric cam locking rings (d).



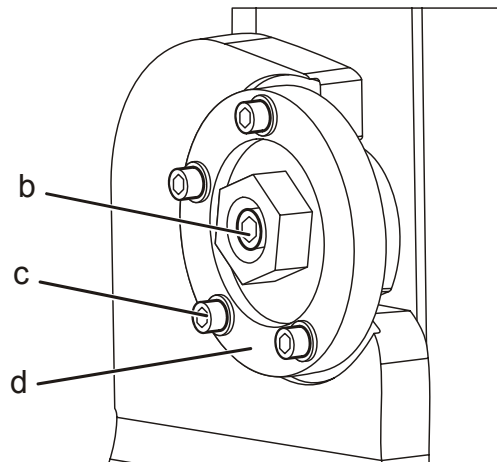
12. Now turn the eccentric cams until the correct lateral incline is achieved, in other words, $90^\circ \pm 6'$.

IMPORTANT!

The eccentric cams must not be turned making the large level surfaces face inwards in the cups on the mast attachment in the reach carriage.

13. Check the incline to the rear ($90^\circ \pm 10'$) once more, and add shims as needed.

14. Tighten the screws (c) on the locking ring (d) to 124Nm.



15. Tighten the screws (a) of the bottom bracket to
1.6–2.0 ton mast: 519 Nm (one screw)
2.5 ton mast: 266 Nm (two screws)
16. Unscrew the locking screw (b) and apply Loctite 29320 (Loctite 242 Blue) to the threads.
17. Screw in the locking screw (b) until it makes contact.
18. Finally, tighten the locking screw (b) $\frac{3}{4}$ of a turn.
19. Connect the hydraulic hoses to the lift cylinders (H1 and H2) and the free lift cylinder (H3) on the main valve.
20. Connect the hydraulic hoses to the tilt cylinder (A1 and B2).
21. Connect any electric cables for extra functions on the mast.
22. Bleed the hydraulic system - see the section "Hydraulic system, bleeding".

Mast/Lift system 7000

Main lift chain system (7120)

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15.2 Main lift chain system (7120)

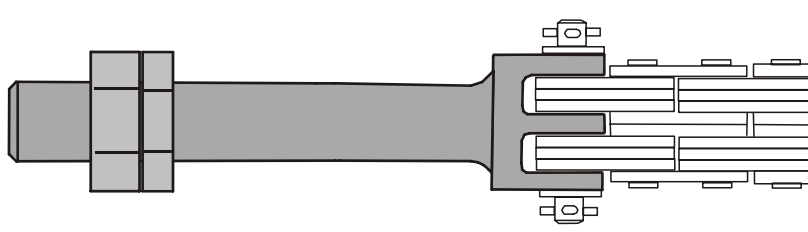
15.2.1 General

Applies to all trucks with masts.



DANGER!

When replacing a chain, the chain bolt should also be replaced.



15.2.2 Inspecting the chain

The chains are subject to two types of wear – plate wear and chain elongation. Elongation is caused by wear to the bolts and plate holes. The chains are also affected by the environment in which they are used.

Noise

If there has been insufficient lubrication, there will be metallic friction on the chain and this will result in noise.

The chain should be replaced.

Surface rust

Surface rust is easy to recognize as the chain will be reddish brown. Deep-seated rust has generally started and the strength of the chain is impaired.

The chain should be replaced.

Rusty links

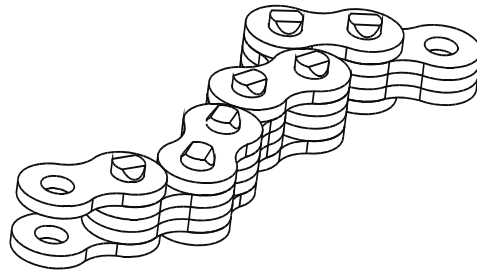
Fretting corrosion results in a reddish brown powder being visible near the outer plates. The chain can also appear to bleed when lubricated.

The chain should be replaced.

Stiff links

If it is not possible to pull the chain out to its normal position this can be due to link rust or seizing.

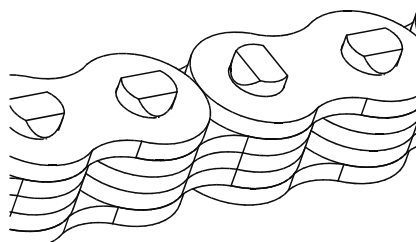
The chain should be replaced.



Bolt rotation

Bolt rotation can be a phenomenon related to stiff links. The fault is easy to see if the chain is compared with a new one.

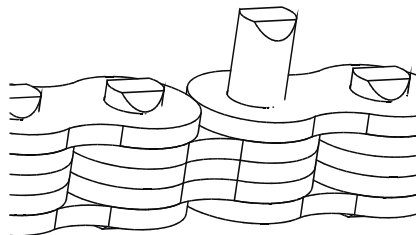
The chain should be replaced.



Loose bolts

If a bolt is loose it will protrude from the side of the chain, and this is due to a stiff link or bolt rotation.

The chain should be replaced.



Mast/Lift system 7000

Main lift chain system (7120)

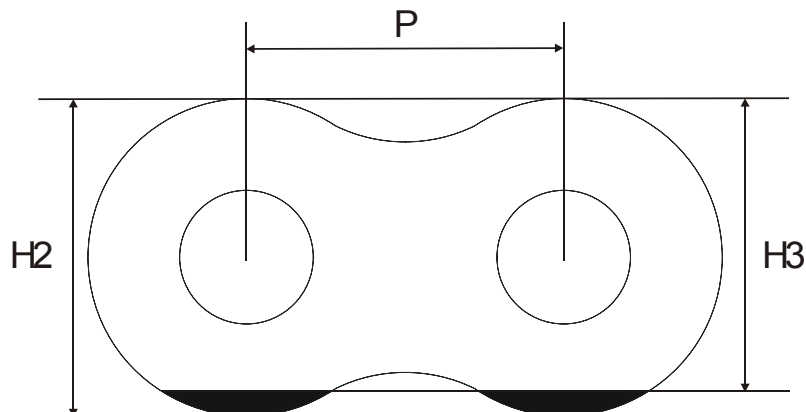
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Plate wear



P = Pitch

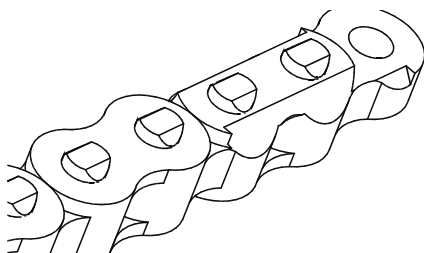
H2 = Nominal plate height.

H3 = Minimum plate height.

A new lift chain has a specific nominal plate height, indicated by H2 in the figure. As the truck is used, the lift chain is subject to radial wear on the side that passes over the chain wheel. The minimum plate height, H3 in the figure, indicates the minimum permitted value of the plate height.

Maximum permitted plate wear is 5% of the H2 height. If a lift chain has reached the maximum degree of wear, the chain must be replaced.

The nominal and minimum plate heights for the relevant lift chain are specified in the table in the section "Elongation".



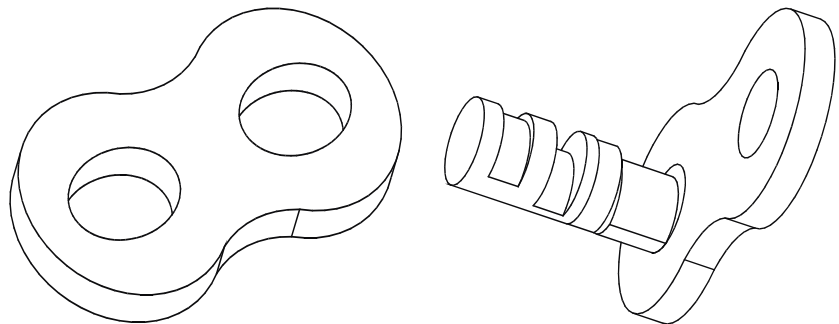
Elongation

The elongation of a lift chain is measured on the part of the chain that passes over the chain wheel. Elongation in the section of chain where wear is greatest may not exceed 2%. The measurement is best made over 300-1000 mm of chain.

The nominal and maximum permitted chain lengths for the relevant lift chain are specified in the table below.

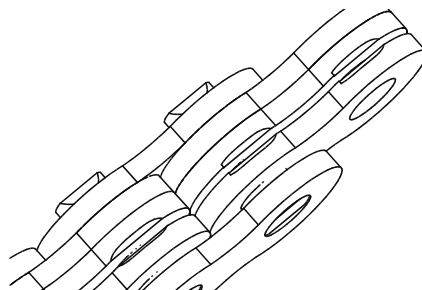
Type of chain	Nominal plate height H2 (mm)	Minimum plate height H3 (mm)	Pitch P (mm)	Nominal chain length for 20/30/50 plates (mm)	Maximum permitted chain length for 20/30/50 plates (mm)
3/4", 2x3	17.8	16.9	19.05	381/572/953	389/583/972
3/4", 3x4	17.8	16.9	19.05	381/572/953	389/583/972
3/4", 4x6	17.8	16.9	19.05	381/572/953	389/583/972
1", 4x4	23.6	22.4	25.4	508/762/1270	518/777/1295
1", 6x6	23.6	22.4	25.4	508/762/1270	518/777/1295

One cause of chain elongation is wear on the bolts and around the holes in the plates. The chain must be replaced if elongation exceeds 2%.



Damage

If there is any other damage, the chain should be replaced.



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Main lift chain system (7120)

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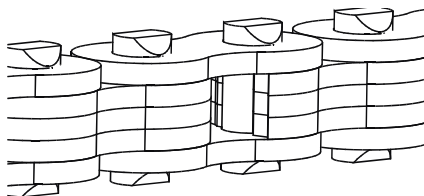
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Damaged plates

If a plate has broken on the chain, this may be due to overloading or corrosion.

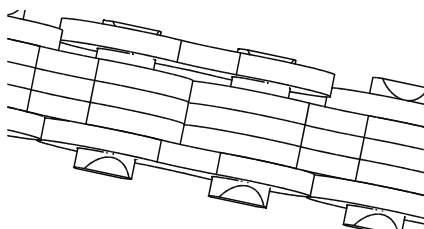
The chain should be replaced.



Damaged bolts

It can be difficult to determine whether a bolt has broken. A broken bolt can manifest itself as bolt rotation and/or a loose outer plate.

The chain should be replaced.



Dirty chain

If a chain is very dirty the recommendation in the first instance is that it should be replaced. It can also be removed and cleaned - see "Cleaning the chain".

15.2.3 Lubricating the chain

Mineral and synthetic oils can be used to relubricate Rexnord chains.

IMPORTANT!

Lubricant must not contain substances such as molybdenum disulphide, PTFE, or similar.

A lift chain must be released from the weight of the fork carriage (suspended) when lubricated.

The chains are sprayed with lubricant. Note the entire chain must be lubricated, including the fixing bolts. It is particularly important that the part of the chain that runs over the chain wheel is well lubricated.

The lubricant must meet the viscosity requirements for the temperatures in question - see "1.1 Oil and grease specifications" on page 1.

IMPORTANT!

Do not use a special rust protective agent to prevent rust attack on the lift chains.

These agents impair lubrication of the chains. Regular lubrication is the best way of preventing rust attack.

15.2.4 Main lift chain system, adjusting the fork-to-floor distance

The lift chains must be adjusted at regular periods due to elongation. Chain adjustment is checked as part of regular maintenance as specified in the maintenance schedule.

Using the free lift chain and main lift chains, the mast runners should be adjusted so that the bottom part of the mast is level.

Then the forks are adjusted so that the fork holes are 10-15 mm from the floor.



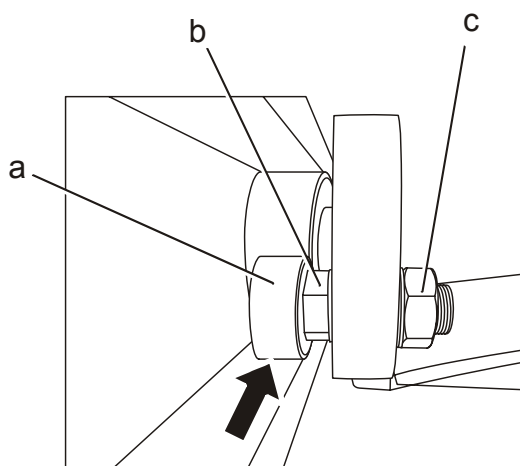
IMPORTANT!

The forks should be tilted into their horizontal position.

15.3 Reach carriage (7190)

15.3.1 Adjusting radial play in the reach carriage

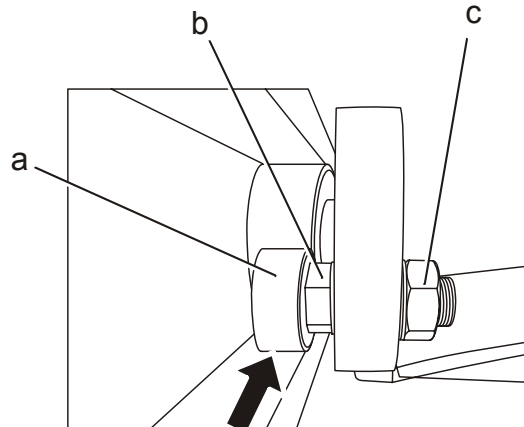
1. Run out the reach carriage and the battery.
2. Lift the battery off, but put it in a position so that it can be connected up, alternatively so that power can be supplied to the truck from a different external source.
3. Place a load on the forks. The weight of the load must be great enough for both the right and left rear roller to sit flush against the top beam flanges.
4. Place the eccentric rollers (a) against the bottom flange and tighten the lock nut (c) (36 mm hexagonal nut) until the axles (b) can rotate (32 mm hexagonal fitting), but provide some resistance. (Once the nut has been placed against the washer, tighten the nut (c) by approximately 0.5–1 turn.)



5. Check that the eccentric rollers are up against the beam (arrow) once the nut has been tightened.
6. Slowly run the reach movement fully in and out again; do this carefully so that the load holds the rear runners against the top beam flanges for the entire time.

7. Once the reach carriage is back in its original position, use a feeler gauge to check play between the eccentric rollers and the beam flange (arrow).

It should be easy to insert the feeler gauge without using force. A suitable interval on the feeler gauge is 0.1 mm.



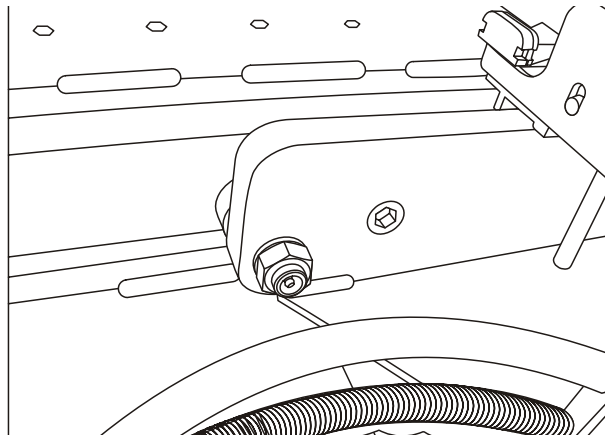
8. Select a feeler gauge that is 0.1 mm thicker (or a minimum of 0.3 mm) than the one that can be inserted between the roller and flange.
9. Turn the eccentric axle (b) to increase play with the flange, insert the feeler gauge you have selected, and turn the axle back so that there is slight pressure from the eccentric roller against the feeler gauge.
10. Tighten the lock nut (36 mm hexagonal nut) to 220 Nm. Make sure you brace the axle so that it does not rotate as the nut is tightened.
11. Withdraw the feeler gauge. (If the feeler gauge has got stuck, give the tool in the eccentric axle a slight tap in the opposite direction so that the feeler gauge comes loose).
12. Reset the truck for normal operation.

15.3.2 Adjusting axial play in the reach carriage

When adjusting lateral play in the reach carriage, it is important that:

- the wheel on each side is adjusted by the same amount
- the reach carriage is centred in the chassis
- the carriage runs straight and smoothly without jamming or coming loose.

1. Fully run out the reach carriage.
2. At each roller, measure the play between the reach carriage and support arms.
3. Remove the locking screw (a) (16 mm allen screw) from the adjuster of each roller.
4. Adjust the rollers (10 mm allen screw) so that the reach carriage is parallel with the support arms and centred between the support arms.



5. Once the reach carriage has been correctly adjusted, place the adjusting rollers against the support arm and turn the adjusting screws back one $\frac{1}{4}$ turn.
6. Lock the adjusting screws.
7. Test run the reach carriage out and in, making sure the carriage runs smoothly without jamming.
8. Check that the rollers come up against the reach stop at the same time as the carriage is run fully out.
9. If necessary, adjust the stop on the side the roller strikes first by sanding it down until both rollers strike the stop simultaneously.

15.4 Lifting devices (7400)

15.4.1 Forks

General

Inspections and inspection intervals refer to ISO standard 5057.

Inspection

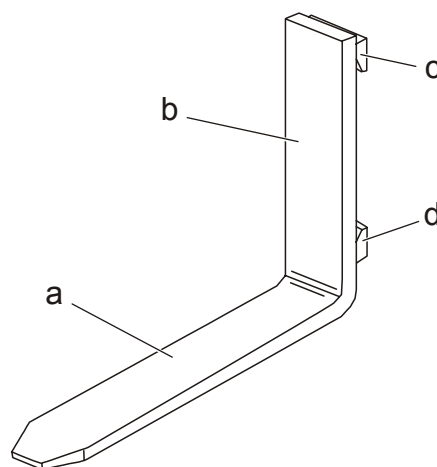
The forks must be carefully inspected by trained personnel. The aim of an inspection is to discover any damage, malfunctions, deformation or similar that may impair safety. A fork with such defects must be taken out of service and must not be used until it has been repaired in a satisfactory manner and, where necessary, tested as per "15.4.2 Forks, repairs and testing".

Inspection intervals

Forks in operation must be inspected at intervals of no more than twelve months and whenever a defect or permanent deformation is discovered. In the case of demanding applications, more regular inspections may be necessary.

Surface cracks

The fork (a) must be subjected to a careful visual inspection for cracks and, if necessary, a non-destructive crack indication check. Pay particular attention to the tilt stop and the upper and lower hooks (c, d), including their attachments to the shaft (b). The fork must be taken out of service if surface cracks are discovered.



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Difference in height between the fork tips

Check a set of forks to see if there is any difference in height once they are installed in the fork holder. If the difference in tip height exceeds 3% of the blade length or the limit value recommended by the truck manufacturer, the set of forks in question must be taken out of service.

Affected fork sets must not be used again until they have been readjusted and tested as per "15.4.2 Forks, repairs and testing".

Position locks

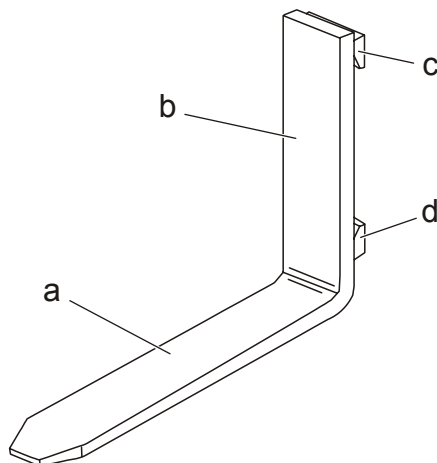
Check that the position lock (if included in the delivery) is in good condition and fully functional. If any fault is found, the fork must be taken out of service until it has been repaired in a satisfactory manner.

Legible markings

If the marking on a fork as per ISO 2330 is not clearly legible, the fork must be taken out of service.

Fork blades and shafts

The fork blade (a) and shaft (b) must be carefully checked for wear. Pay particular attention to the area around the tilt stop. If the thickness of the blade or shaft has been reduced to 90% of the original thickness, or to the minimum thickness specified by the fork or truck manufacturer, the fork must be taken out of service.



Mounting fixings on the fork

Check the upper hook's support surface and the attachment surfaces of both hooks for wear, crushing or other localised deformation. If the defects are so obvious that play between the fork and fork holder becomes excessive, the fork must be taken out of service. Perform similar checks on other types of mounting fixings.

15.4.2 Forks, repairs and testing

Repairs

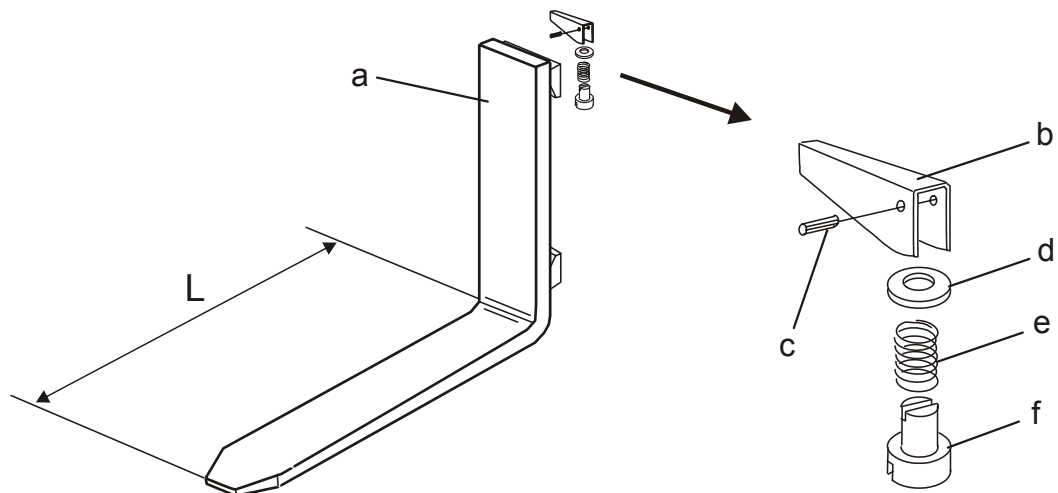
Only the fork manufacturer or a specialist of equivalent expertise may determine whether the fork may be repaired and then used again. Repairs must only be carried out in accordance with the recommendations of the fork manufacturer. It is not recommended that surface cracks or wear be repaired by welding. If repairs are required to restraighen the fork, the fork must then be heat-treated in a suitable manner.

Testing the yield point

A repaired fork (except on repairs to or replacement of position locks and/or markings) may only be used again if it has undergone a yield point test as described in ISO 2330 and been approved. However, the test load must conform with the table.

Specified capacity for fork, m	Test load F_t
$m \leq 5000$	$2.5 m$
$m > 5000$	$2.1 m$

Fork



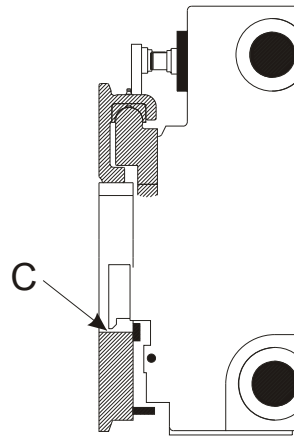
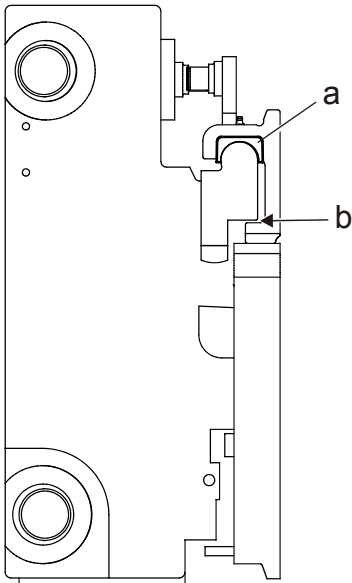
- a. Fork
- b. Bracket
- c. Tension pin
- d. Washer
- e. Spring
- f. Lock

15.5 Fork carriage

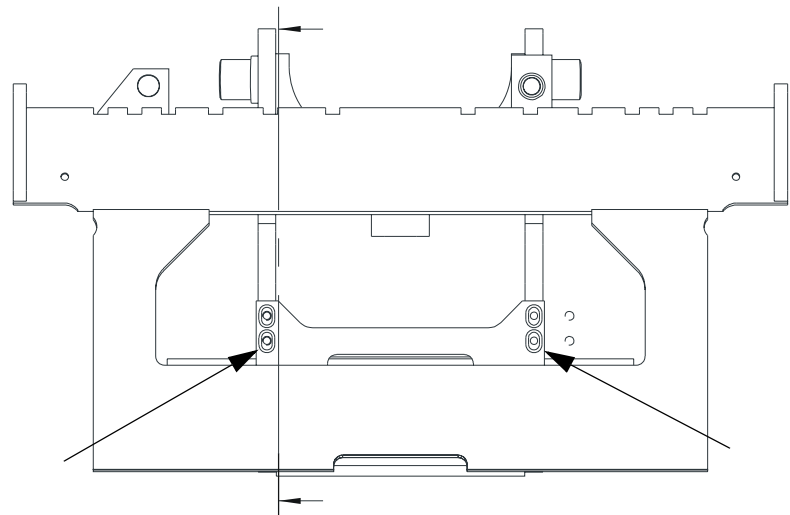
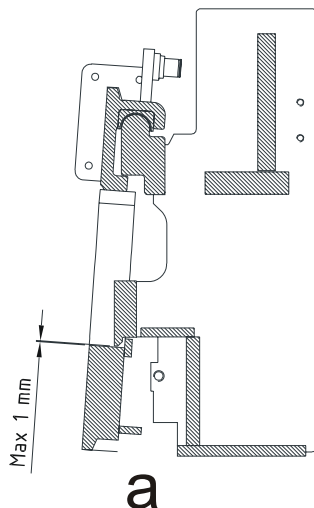
15.5.1 Checking the fork carriage's wear strip

The wear strip (a) between the yoke and ball beam on the fork carriage is subject to wear and must be checked annually.

1. Measure the gap (b) between the yoke and the ball beam. When the wear strip is new, the gap is 2 mm. If the gap is 4 mm or more, the wear strip must be replaced.
2. Check the gap (c) between the stop lug and the fork yoke as well. On maximum upward tilt angle, play should be a maximum of 1 mm.



3. Place a 1 mm feeler gauge between the fork yoke and stop lug to check and adjust the distance. The feeler gauge can be removed once the forks have been tilted down. Tighten the four screws to 45 ± 11 Nm.
4. The gap can be adjusted with the screws on the stop lug (see the screws marked with arrows).



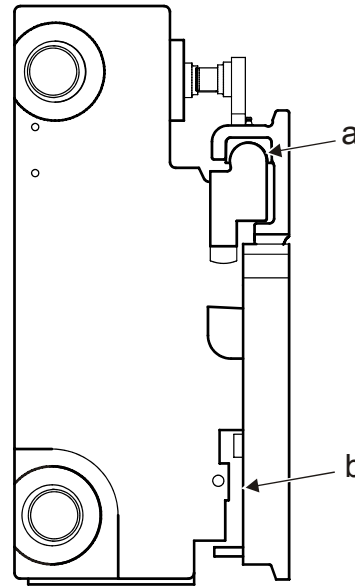
a: Maximum tilt angle

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15.5.2 Lubricating the fork carriage

The following locations should be lubricated once a year:

- Between the ball beam and the wear strip of the side shift unit (a)
- Between the yoke and the friction plate (b)

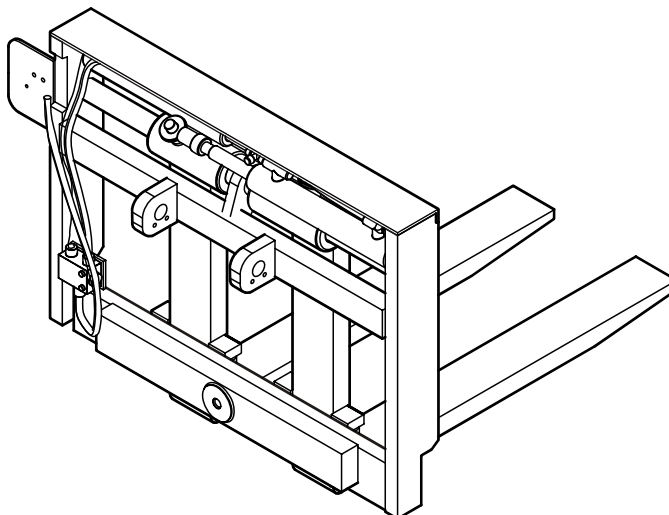


15.6 Fork spread unit

15.6.1 Servicing the fork spread unit

On usual truck servicing, the following points should be checked/carried out:

- Lubrication of friction plates against fork and ball beam.
- Push grease into the grease nipples when servicing the truck. The brass bushings in the fork sleeve and in the support rollers provide some degree of lubrication, as they are provided with graphite in-lays.
- During lubrication, use a graphite grease, e.g. Q8 Rembrandt EP2.
- Check bearings and axles, and replace wear parts if there is substantial play in the fork sleeve.
- If the upper chromed axle has been damaged, this must be replaced immediately. Wear on the lower support rollers is the result of the forks being used frequently for lateral conveyance. In very dirty environments, these should be checked more often than in normal environments.
- Check the forks. The thickness of the blade or shaft should be at least 90% of the original thickness in accordance with ISO 5057.
- Check the screws and nuts. If necessary, tighten as normal.

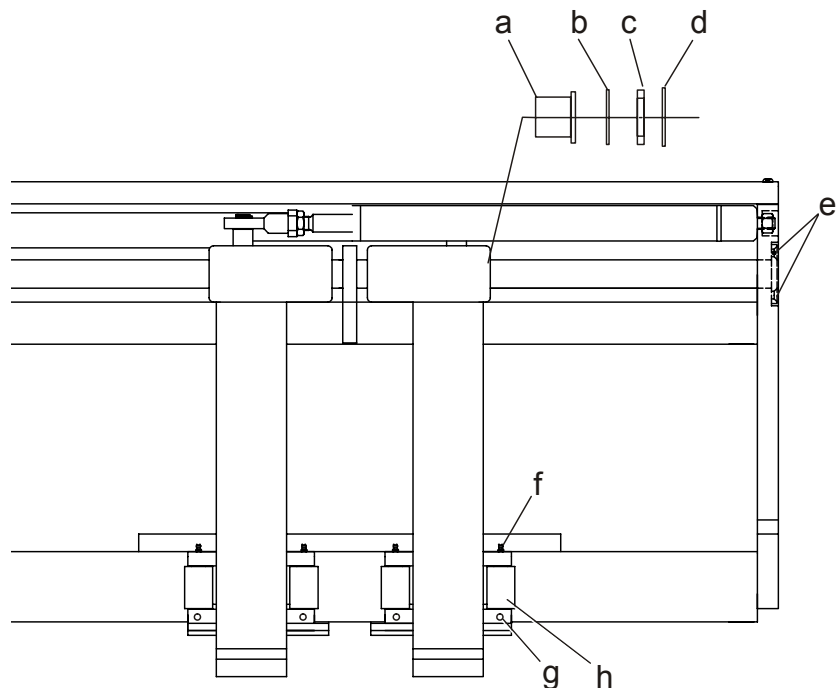


Replacing bearings

1. Remove the outer lock ring (d) and wiper seal (c).
2. Remove the inner lock ring (b) and wiper seal.
3. Remove the bearing (a).
4. Fit the new bearing and refit the outer and inner lock rings and wiper seal.
5. Apply locking fluid to the screws (e) on fitting.

Replacing the rollers

1. Remove the tension pin (g) from the fork lug.
2. Push the axle (f) out.
3. Remove the roller (h).
4. Place a new roller in position.
5. Push the axle in.
6. Fit the tension pin.



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15.7 Fork extensions with adjustable fork length

A standard fork can be extended with adjustable fork extensions. In this way you can carry bulkier items. When the fork extension is fitted, a check is made that it is suitable for fitting to a standard truck fork (see the details on the identification plate).

Only use in pairs when the specified fork dimensions match, and the length of the truck fork is greater than or equal to the minimum permitted truck fork length.

IMPORTANT!

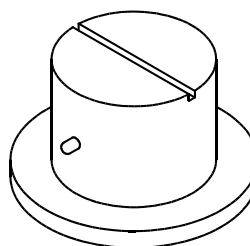
Please note that load capacity is reduced once the fork extensions are attached.

IMPORTANT!

The fork extension must not be used if the mounting is unsafe or if it is damaged, dirty or icy. The chamfered underside must face downwards. Daily visual inspection is recommended.

- The fork extension must be regularly maintained, and inspected once a year.
- If at any point the plate thickness of the fork extension is less than 3 mm, the fork extension must be replaced immediately.
- If the fork extension shows signs of distortion, cracks or other damage, it must immediately be taken out of service.
- A crack indication check must be performed using the dye penetration method.
- Check the function and safety of the locking pin.

To fit the forks, use the following locking pin:



Check that the fork extension is firmly attached; pull on the fork extension to check it is secure.

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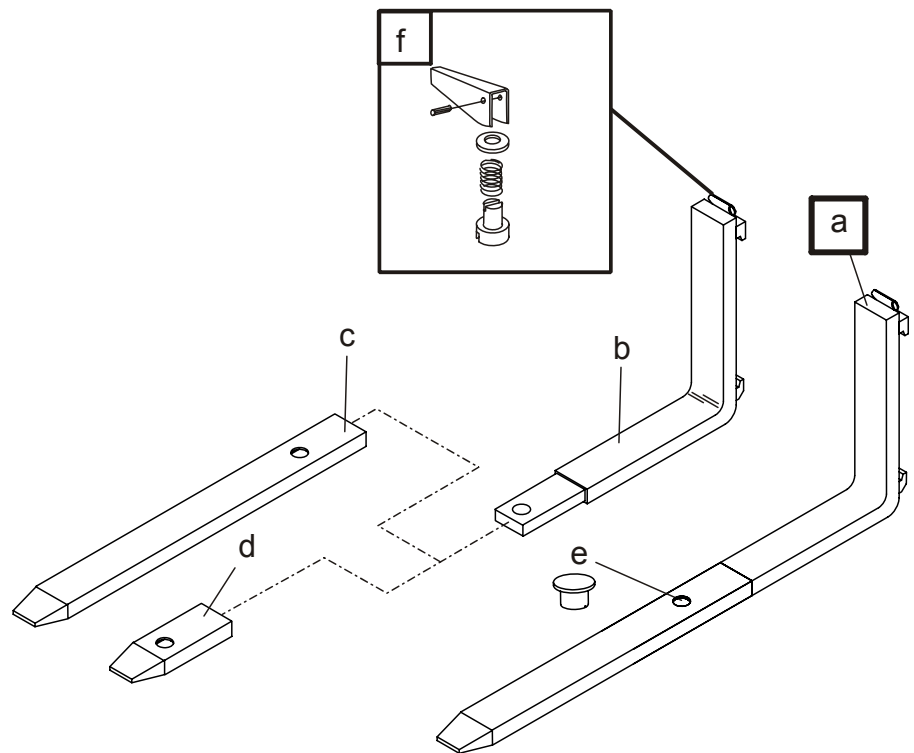
Fork extensions with adjustable fork length

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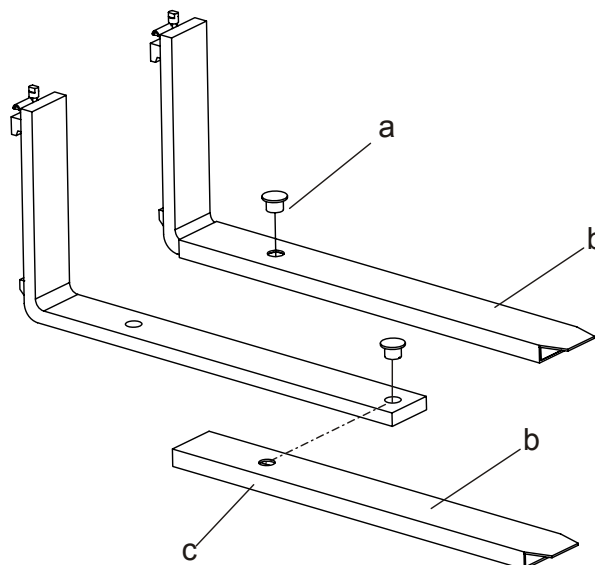
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- a. Fork extension
- b. Fork, main segment
- c. Fork, extension
- d. Fork, extension
- e. Pin
- f. Lock

15.8 Manual telescopic forks



15.8.1 Fitting



DANGER!

Risk of injury. Fingers, other body parts or objects may not be inserted in the holes on the fork blade or extended section. These holes are only intended for locking with locking bolts.

1. Push the bolt (a) upwards until it reaches the stop.
2. Turn the bolt anticlockwise until it is held by the stop.
3. Remove the bolt.
4. Push/pull the extended section (b) to the required position. Use the handle under the tip on the extended section.
5. The hole in the extended section must be in line with a hole in the original fork, so that the extended section can be attached to the original fork.
6. Avoid using too much force to position the extended section, as this can damage the stop screw (c).
7. Place the bolt in the hole. Check that the grooves in the bolt correspond to the original fork.
8. Turn the bolt clockwise until it is held by the stop.

IMPORTANT!

The locking bolts must not stick up above the surface of the fork. The bolt must be correctly inserted. The fork must not be used until the bolt has been correctly secured.

Avoid using too much force to pull the extended section towards the end stop, as this can damage the stop screw.

The stop screw (c) must be screwed into the extended section and secured using Loctite 242, for example. It may only be removed to allow replacement of the extended section. It must then be screwed back in and secured.

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15.8.2 Maintenance

It is not necessary to grease the original fork or the extended section. Remove any dirt using a wire brush, for example.

The fork must be inspected annually.

The following checks are to be performed:

- The function of the fork arm's locking device at the fork attachment point
- The function of the extended section's locking device
- The function of the stop screw (it must not be possible to remove the extended section)
- Check the original forks for deformation (90 degree angle)
- Check for wear on the original fork (10% rule)

When the thickness of the steel on the extended section has been reduced to 3 mm or less at any point of the extended section, this must be replaced. Wear to the extended section occurs most often near the heel or under the fork tip. If wear to the original forks is 10% or more of the nominal thickness, the original fork must also be replaced. (ISO 5057)

- Check for cracks in the fork heel and extended section
- Check for wear to the extended section ($t \geq 3$ mm)
- Check the extended section for deformation and cracks
- Check the locking bolt and its function

IMPORTANT!

Always replace the forks in pairs.

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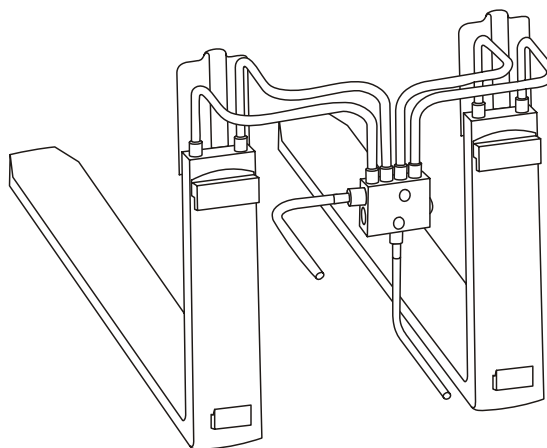
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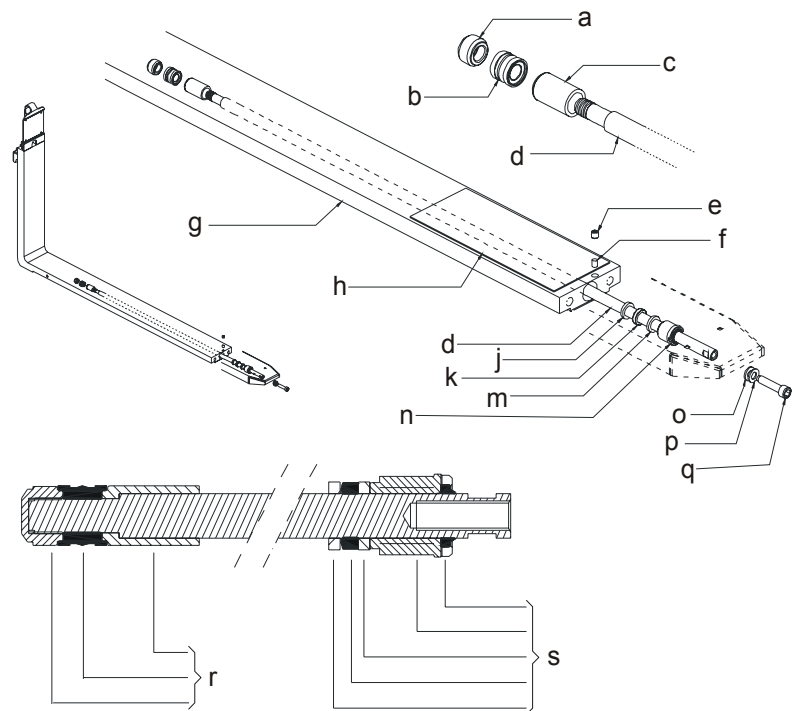
15.9 Hydraulic telescopic forks

The KOOL forks can be extended hydraulically.

They come in two types: telescopic forks with separate flow dividers and telescopic forks with an integrated system for flow distribution.



15.9.1 Telescopic forks with separate flow dividers



- | | |
|--------------------------------|-----------------------------|
| a. Piston section 2 | j. Support ring |
| b. Piston seal | k. Rod seal |
| c. Piston section 1 | m. Support ring |
| d. Piston rod | n. Complete cylinder head |
| e. Attachment screw | o. Washer |
| f. Plastic plug | p. Washer |
| g. Serial number on inner fork | q. M10 special bolt |
| h. Sealing strip, inner fork | r. Piston with seals |
| | s. Cylinder head with seals |

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Hydraulic telescopic forks

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Fitting instructions

The telescopic forks' identification plates are marked with an L (left side) and an R (right side). The forks are fitted on the fork yoke to the left and right as per the markings viewed from the operator compartment. Push the forks onto the fork yoke and check that the locking pin is correctly positioned in the hole on the yoke.

Fit the flow divider on the back of the fork yoke. The flow divider must be fitted in a horizontal position to ensure correct function of the hydraulic circuit. Connect the accompanying hydraulic hose(s) to the telescopic forks and the hoses from the forklift truck. Check that all connections are correctly tightened and secure.

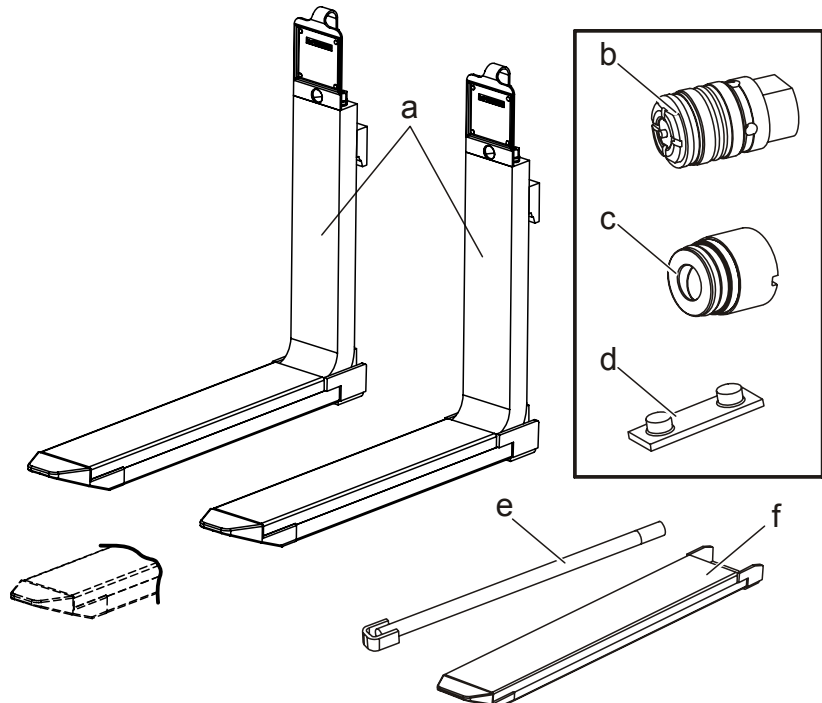
The maximum fluid pressure for the telescopic forks is 20 MPa (200 bar).

Initial operation of telescopic forks with separate flow dividers

Before the forks can be used, the system must be bled.

1. Run the forks in and out ten times.
2. Move the mast from its front to rear position several times.
3. Run the forks in and out ten times.
4. Check that the hoses can move freely.
5. Check the system for oil leaks.

15.9.2 Telescopic forks with integrated flow dividers



- a. Telescopic forks, pair of forks
- b. Piston
- c. Cylinder head
- d. Friction plate
- e. Outer fork
- f. Piston rod

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Fitting instructions

The telescopic forks' identification plates are marked with an L (left side) and an R (right side). The forks are fitted on the fork yoke to the left and right as per the markings viewed from the operator compartment. Push the forks onto the fork yoke and check that the locking pin is correctly positioned in the hole on the yoke.

Connect the accompanying hydraulic hose(s) to the telescopic forks and the hoses from the forklift truck. Check that all connections are correctly tightened and secure.

The maximum fluid pressure for the telescopic forks is 20 MPa (200 bar).

Initial operation of telescopic forks with integrated flow dividers

Before the forks can be used, the system must be bled.

1. Move the mast between its front and rear position a number of times.
2. Push the telescopic forks back using the control. Hold the control in the rear position for approximately one minute so that the forks remain pushed back and are flushed.
3. Move the forks in and out a number of times.
4. Check that the hoses are not blocked and that the system is not leaking oil.

15.9.3 Maintenance of telescopic forks

IMPORTANT!

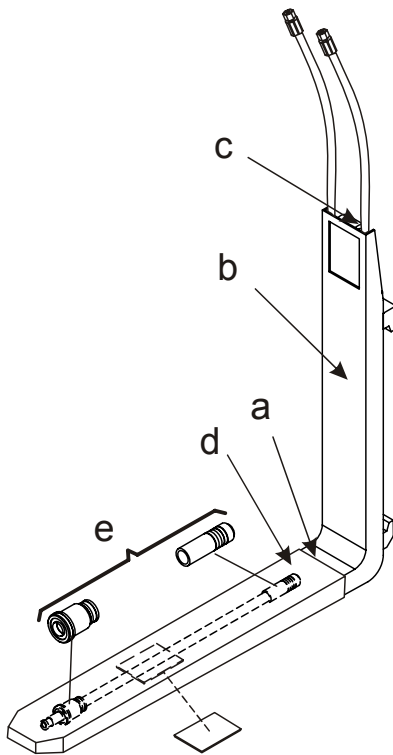
Whenever servicing the telescopic forks, the truck must be turned off and the battery disconnected.

During maintenance, the hydraulic system must be depressurised.

If the telescopic forks are removed, the forks' couplings must be sealed to prevent dirt from entering the hydraulic system.

IMPORTANT!

The forks are replaced as a pair. If one fork is damaged to the extent that it must be replaced, both forks must be replaced.



1. Lubricate the top of the inner fork as required. Lubricate with calcium grease (e.g. Q8 Ruysdael WR2). (a)
2. Check the wear on the forks' underside and wear plate, particularly on the back. Check the inner fork as per ISO 5057, with the exception of "fork blades and shafts", as the inner fork is not subject to wear (b).
3. Check for hydraulic leaks/damage. Examine the cylinder head to ensure there are no leaks. (This is easy to see once you remove the outer fork (d)).
4. If the telescopic fork tilt stops are leaking, they must be removed immediately. If the couplings are leaking, these must be tightened or replaced. (c)
5. If the wear plate on the underneath of the forks is completely worn, or if the outer fork sleeve is starting to rub against the wear plate, the wear plate must be replaced with a new one to prevent damage to the outer fork sleeves and the inner fork.
6. Once the outer fork has been removed you can easily check the cylinder head. (e)

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15.9.4 Dismantling telescopic forks

IMPORTANT!

Whenever the telescopic forks are serviced, the truck must be turned off and the battery disconnected.

During maintenance, the hydraulic system must be depressurised.

If the telescopic forks are removed, the forks' couplings must be sealed to prevent dirt from entering the hydraulic system.

1. Operate the forks to waist height and tilt the mast to its forward position.
2. Switch off the truck and then withdraw the battery cut out connector.
3. Remove the outer fork by removing the attachment bushings for the spirals. Be careful not to damage the piston rods.
4. Unscrew the couplings on the back of the fork, so that the piston rods do not create a vacuum when removed.
5. Remove all Loctite from the coupling threads.
6. Undo the fixing screw between the two cylinder heads.
7. Place a collection vessel under the forks. Undo the cylinder head using the cylinder head spanner. The right cylinder head (as viewed by the operator) must always be unscrewed first, as there is a plastic plug underneath the fixing screw.
8. Carefully remove the piston rods. Note that there are two loose support rings on each side of the piston ring seal. Remember to replace these when installing the piston rod on the fork.
9. The piston can now be unscrewed. To prevent the piston rod being damaged while the piston is being unscrewed, it must be secured in position to prevent the piston rotating. Due to the presence of Loctite sealant, the pistons on forks with integrated flow dividers must be heated with a burner before they can be unscrewed.
10. The cylinder head can now be removed from the piston rod.
11. Replace the parts.
12. Remove all Loctite from the piston rod thread.
13. Clean the piston rod and thread with Loctite 7063.
14. The cylinder head can now be reinstalled on the piston rod.

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15.9.5 Assembling telescopic forks

1. Once the pistons are fully attached to the piston rod, they must be secured with Loctite. For forks with a separate flow divider, use Loctite 542. For forks with integrated flow dividers, use Loctite 270.
2. Hold the piston rod (together with the piston and cylinder head) in line with the cylinders and carefully tap them in.
3. Apply copper paste to the cylinder head thread.
4. Replace the cylinder head using the cylinder head spanner.
5. Once all piston rods are in, tighten the fixing screw again.
6. Now tighten the couplings (secure with Loctite 542).
7. Run the forks out to approximately 150 mm.
8. The outer forks can now be installed. Make sure that the piston rod holders end up immediately under the holes in the outer fork.
9. Place a screwdriver or a screw in one of the holes and hammer in the attachment bushings for the spirals with a heavy hammer. Remove the screwdriver or screw and hammer in the other attachment bushings for the spirals.
10. For forks with integrated flow dividers, the truck must be started and the forks held retracted for approx. one minute using the lever, so that air is vented from the system, which then fills with oil. For forks with separate flow dividers, the forks must be extended and retracted several times.

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16 – External Equipment 8000

16.1 Introduction

This section is reserved for future use.

External Equipment 8000

Introduction

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17 – Options 9000

17.1 Introduction

This section is reserved for future use.

Options 9000

Introduction

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18 – Appendix “Destruction instructions”

18.1 General

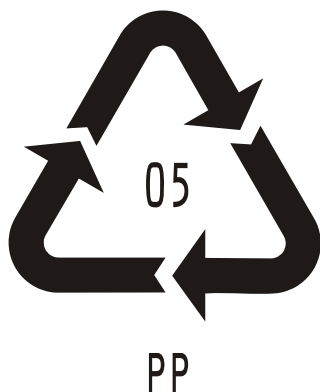
These destruction instructions have been introduced to support our company's objective of protecting the environment. By recycling materials, resources can be utilised more efficiently, while emission of undesirable substances is reduced.

The instructions below indicate the proper sorting category for the materials used in the various truck components. To achieve optimum sorting, all components should be disassembled to a level corresponding to the sorting categories.

18.2 Marking of plastics

18.2.1 General marking of products and packaging material

Markings on plastics consist of three arrows, a number and usually also a designation for the plastic material used. The picture shows an example with the marking for polypropylene.



- 01: PET – Polyethylene terephthalate
- 02: PE-HD – Polyethylene with High Density
- 03: PVC – Polyvinyl chloride
- 04: PE-LD – Polyethylene with Low Density
- 05: PP - Polypropylene
- 06: PS – Polystyrene
- 07: O – Others

Appendix “Destruction instructions”

Marking of plastics

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18.2.2 Marking according to our standard

Standards: 58-02-001, 58-02-003 and 58-02-004.

Only a few examples of markings are presented here. For more information, please refer to the standards mentioned above.

The product material and trade name are indicated between arrows. Example: >PP<.

Abbreviations

- ABS: acrylonitrile/butadiene/styrene
- HDPE: High Density Polyethylene
- LDPE: Low Density Polyethylene
- PA: Polyamide
- PA6: Amide resin 6
- PA66: Amide resin 66
- PBT: Polybutylene terephthalate
- PC: Polycarbonate
- PET: Polyethylene terephthalate
- PMMA: Plexiglas
- POM: Polyoxymethylene, Polyformaldehyde
- PP: Polypropylene
- PUR: Polyurethane

Marking examples

Products made from a single substance

ABS (acrylonitrile/butadiene/polystyrene):

>ABS<

Polyurethane:

>PUR<

Plastic compounds

A compound based on acrylonitrile/butadiene/polystyrene and carbonate plastic:

>ABS+PC<

Filled or reinforced materials

Polypropylene with 30% mineral powder:

>PP-MD30<

18.3 Pressure vessels

Pressure vessels sent for recycling/destruction must have been depressurised beforehand and, if possible, opened.

Examples of existing pressure vessels are gas dampers and accumulators used in hydraulic systems.

18.3.1 Gas dampers

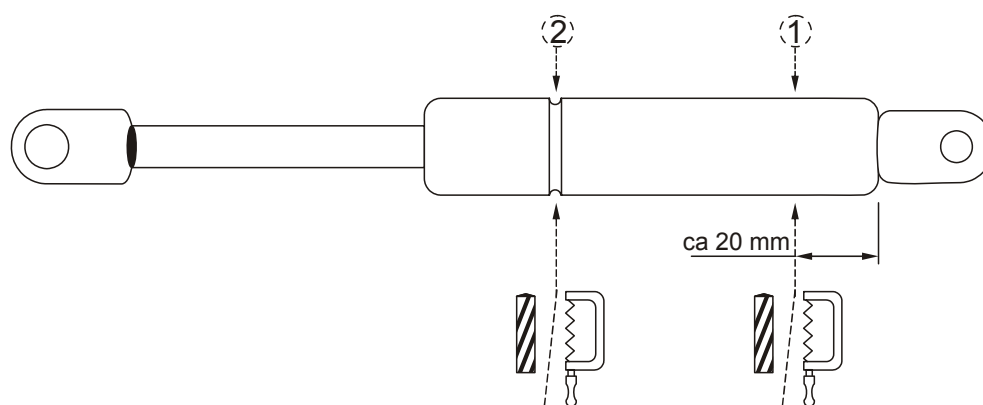


DANGER

Gas dampers have extremely high internal pressure. To prevent injury, always heed the instructions of the manufacturer.

Use safety goggles when disassembling springs.

To allow the gas to escape, only open and disassemble gas dampers as prescribed by the manufacturer. An example of how to perform this is given for “Stabilus Lift-O-Mat/Inter-stop”:



1: Drill or cut a hole in the cylinders, approximately 20 mm from the bottom.

2: Drill or cut a hole in the cavity at the piston rod end.

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Sorting categories

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18.4 Sorting categories

- Plastic and rubber material
- Iron/steel (including bolts, washers and nuts)
- Oils
- Oil filters
- Oil-polluted material
- Electronic parts (including switches and sensors)
- Cables
- Hazardous waste
- Complex materials - large amounts of several categories but non-combustible and not hazardous
- Combustible material (including small plastic and rubber parts)
- Please return batteries to the manufacturer.

COMPONENT	Category	Comment
Chassis	<ul style="list-style-type: none">• Iron/steel	
Covers and doors, sheet metal	<ul style="list-style-type: none">• Iron/steel• Handles: >ABS<	
Covers and doors, plastic	<ul style="list-style-type: none">• Plastic	Sort according to the material marking
Forks and bodies	<ul style="list-style-type: none">• Iron/steel	
Operator platforms	<ul style="list-style-type: none">• Iron/steel, also possible gas dampers• Mats, cushions: combustible	Be sure to depressurise dampers
Roofs and overhead guards	<ul style="list-style-type: none">• Iron/steel	
Gates and operator protective devices	<ul style="list-style-type: none">• Iron/steel• Plastic handles: >PA<• Crush protectors: >PMMA<	
Hydraulic units	<ul style="list-style-type: none">• Oil• Hydraulic hoses: Oil polluted material• Oil tank: >PP<• Motor, valves: Electronic parts• Pump: Iron/steel• Accumulator: Iron/steel	Ensure the system has been depressurised. Carefully drain all oil. Any accumulators should be emptied of gas and if possible opened.

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Sorting categories

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COMPONENT	Category	Comment
Travel drive motors	<ul style="list-style-type: none"> Motor: Electronic parts Cables Parking brake: Hazardous waste 	
Drive gears	<ul style="list-style-type: none"> Iron/steel Oil 	Carefully drain all oil. Hazardous waste
Wheels	<ul style="list-style-type: none"> Tread: Plastic according to marking Hub: Iron/steel 	If the tread and hub cannot be separated, then sort the wheel as complex material
Tiller arms	<ul style="list-style-type: none"> Electronic parts Cables Iron/steel, also gas dampers 	Be sure to depressurise dampers
Electric systems	<ul style="list-style-type: none"> PCBs, transistor regulators, Expansion unit SEU, contactors: Electronic parts Cables 	Hazardous waste
	<ul style="list-style-type: none"> Small batteries 	Hazardous waste
	<ul style="list-style-type: none"> Fluorescent tubes 	Hazardous waste Because of the chemical content in fluorescent tubes, do not destroy them. Obsolete fluorescent tube must be packaged and transported according to local regulations.
Masts	<ul style="list-style-type: none"> Mast members, rollers, cylinders, hydraulic pipes: Iron/steel Hydraulic hoses: Oil-polluted () Cables Sensors/switches: Electronic parts Plastic components: According to marking or as combustible waste 	Oil-polluted components should be handled as hazardous waste
Chargers and connectors	<ul style="list-style-type: none"> Electronic parts Cables 	

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Sorting categories

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19 – Wiring diagrams

19.1 Components

Designation	Function	Component type	Other
A1	Central Information Display (CID)	PCB with display	
A2	Power steering (EPS)	PCB	
A5	Main microcontroller (MCU)	PCB	
A6	Sensor control	PCB	
A7*	Cabin heating control	PCB	
A9	Power distribution	Fuse box	
A11*	Stereo/CD	Stereo/CD	
A82	Data management unit	PCB	T.W.I.S. unit in the truck
B1	Temperature sensor in [M1]	Temperature sensor	
B2	Temperature sensor in [M3]	Temperature sensor	
B4	Hydraulic lift pressure	Pressure sensor	
B5*	Fork tilt angle	Angle sensor	
B11	Speed measurement [M1]	Pulse transducer	
B12	Speed measurement [M3]	Pulse transducer	
B13	Pulse transducer, steering wheel	Twin sensor bearing	
B17	Reference for 180° steering angle	Inductive sensor	
B18	Height sensor free lift	Sensor	
B19	Height sensor main lift	Sensor	
B20	Raise/lower forks	Hall sensor	Nominal output voltage: 0.5 V (min.) 2.5 V (neutral position) 4.5 V (max.)
B21	Fork carriage in/out	Hall sensor	
B22	Fork tilt up/down	Hall sensor	
B23*	Sideshift right/left	Hall sensor	
B24*	Forkspread/aux	Hall sensor	
B25	Height reference, forks near top of mast	Inductive sensor	
B26	Position for reach carriage, sensor 1	Inductive sensor	Distance: 0-6.5 mm
B27	Position for reach carriage, sensor 2	Inductive sensor	
B28*	Cabin tilt in lowest position	Inductive sensor	
B29*	Cabin tilt in highest position	Inductive sensor	

Wiring diagrams

Components

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Designation	Function	Component type	Other
B30	Battery in original position	Inductive sensor	
B31	Safety pedal	Inductive sensor	
B32	Pedals (acceleration and brake)	Hall sensor	Nominal output voltage: 0.5 V (min.) 4.5 V (max.)
B33	Height reference, mast near bottom position	Inductive sensor	
B35	Horn	Horn	
B36	Travel direction selector	Hall sensor	
B38*	Height preselector, next level	Hall sensor	
B39*	Height limitation override	Hall sensor	
B40*	Forks to horizontal position	Hall sensor	
B41*	Sideshift to centre position	Hall sensor	
B42*	Change of function for fifth mini lever	Hall sensor	
B43*	Cabin tilt activation	Hall sensor	
B44*	Activation of extra function 1	Hall sensor	
B45*	Activation of extra function 2	Hall sensor	
B46	Height reference mast lowering	Inductive sensor	Distance: 0-6.5 mm
B47*	Sideshift sensor left-hand side	Magnetic sensor	
B48*	Sideshift sensor right-hand side	Magnetic sensor	
B49	Seat switch	Inductive sensor	Distance: 0-6.5 mm
B50*	Fork camera	Camera	
B57	Height reference, mast lowering	Inductive sensor	
B58	Height reference, forks below 1 m	Inductive sensor	
B90	Height reference, mast lowering	Inductive sensor	
E3*	Working light	Lamp	
E4*	Working light	Lamp	
E5*	Working light	Lamp	
E6*	Working light	Lamp	
E10*	Seat heater	Resistor	
F1	Fuse for [T1]	Fuse	160 A/200 A
F3	Fuse for [T2]	Fuse	250 A/325 A
F60	Fuse for relays	Fuse	3 A

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Designation	Function	Component type	Other
F61	Main fuse for [A5]	Fuse	7.5 A
F62	Main fuse for [A1]	Fuse	3 A
F63	Fuse for [P6]	Fuse	3 A
F64	Fuse for activation of [A2]	Fuse	3 A
F65*	General Function Unit fuse	Fuse	5 A
F66*	Fuse for [T5] and [T6]	Fuse	7.5 A
F69	Fuse for [X42] and [S133]	Fuse	10 A
F71	Fuse for [A5]	Fuse	7.5 A
F72	Fuse for [A2]	Fuse	30 A
F73	Fuse for control voltage	Fuse	7.5 A
F74	Fuse for [A1] and [A5]	Fuse	3 A
F75*	Fuse for working light	Fuse	10 A
F76*	Fuse for [T3]	Fuse	7.5 A
F77*	Fuse for seat heater	Fuse	10 A
F90*	Fuse for cabin heating	Fuse	100 A (cold store cabin)
F91*	Control circuitry fuse for heater	Fuse	7.5 A (cold store cabin)
F92*	Fuse for heater element	Fuse	25 A (cold store cabin)
F93*	Fuse for heater element	Fuse	25 A (cold store cabin)
F94*	Fuse for heater element	Fuse	25 A (cold store cabin)
F95*	Fuse for heater element	Fuse	25 A (cold store cabin)
G1	Truck battery	Battery	48 V
G3	Cooling of [T1] and [T2]	Fan motor	
G4	Cooling of [M3]	Fan motor	
G5*	Fan for ventilation	Fan motor	(cold store cabin)
K1	Electronic ignition key	PCB	
K20	Key relay	Power relay	460–330 ohms at 48 V DC
M1	Drive motor	3 phase AC motor	
M3	Pump motor	3 phase AC motor	
M6	Steering servo motor	Step motor	
P4	Horn	Horn	
P5*	Warning lamp	LEDs	Flashing: ~2 Hz Nominal current: 70 mA
P6*	Load Information Display (LID)	PCB with display	
P7*	Vehicle alarm	Horn	

Wiring diagrams

Components

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Designation	Function	Component type	Other
P10*	Loud speaker	Loud speaker	
P11*	Loud speaker	Loud speaker	
P12*	Vehicle alarm	Lamp	
P13*	Vehicle alarm	Lamp	
P14*	TV monitor	Monitor	
Q1	Parking brake	Electromagnetic brake	32 ohms
Q2	Valve for main mast lift	Electromagnetic valve	22 ohms
Q3	Valve for initial mast lift	Electromagnetic valve	
Q4	Valve for main mast lowering	Electromagnetic valve	
Q5	Valve for initial mast lowering	Electromagnetic valve	
Q6	Valve for reach carriage in	Electromagnetic valve	25 ohms
Q7	Valve for reach carriage out	Electromagnetic valve	
Q8	Valve for extra hydraulic function, direction A	Electromagnetic valve	25 ohms
Q9	Valve for extra hydraulic function, direction B	Electromagnetic valve	
Q10	Main relay	Contactor	150 ohms
Q11	Valve for cabin tilt upwards	Electromagnetic valve	25 ohms
Q12	Valve for extra hydraulic function 2	Electromagnetic valve	
Q14	Valve for extra hydraulic function 3	Electromagnetic valve	
Q15	Valve for extra hydraulic function 4	Electromagnetic valve	
Q16*	Support arm brake (left)	Electromagnetic brake	
Q17*	Support arm brake (right)	Electromagnetic brake	
Q18	Valve for fork tilt/sideshift	Electromagnetic valve	
Q19	Valve for fork tilt/sideshift	Electromagnetic valve	
Q21	Valve for cabin tilt downwards	Electromagnetic valve	
Q30*	Relay for cabin heating	Power relay	
Q31*	Relay for initial heating	Power relay	
Q32*	Relay for defroster	Power relay	
R1*	Heater element	Heater element	4x400 W
R2*	Heater element	Heater element	4x400 W
R3*	Speed control	Resistor	
R4*	Speed control	Resistor	
R5*	Temperature control	Potentiometer	
R5*	Temperature control	Potentiometer	

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Designation	Function	Component type	Other
R10*	Damping resistance	Resistor	680 ohms
R102	Damping resistance for CAN1	Resistor	120 ohms
R202	Damping resistance for CAN2	Resistor	120 ohms
S21	Emergency switch off	Switch	Normally closed
S96*	Changeover switch, heater fan	Rotary switch	
S99*	Working light off/on	Push button	
S126*	Seat heater off/on	Push button	
S133	Release of parking brake	Switch	
S181*	Power switch, heater coils	Power switch	
T1	Control of drive motor [M1]	Frequency converter	DC to 3 phase AC
T2	Control of pump motor [M3]	Frequency converter	DC to 3 phase AC
T3*	Voltage converter	DC/DC converter	From +48 V DC to +12 V DC
T4*	Antenna	Antenna	
T5*	Voltage converter	DC/DC converter	From +48 V DC to +12 V DC
T6*	Voltage converter	DC/DC converter	From +48 V DC to +24 V DC
T20*	Antenna	Antenna	T.W.I.S.
X1*	Connection for battery	Contact (battery connector)	
X3	Connection for battery	Contact (battery connector)	
X26*	Connection for General Function Unit (GFU)	Contact	
X41	Connection for service key	CAN contact	
X42	Socket 48 V DC	Contact	
X43*	Socket 12 V DC	Contact	
X44*	Socket 24 V DC	Contact	

* option

Wiring diagrams

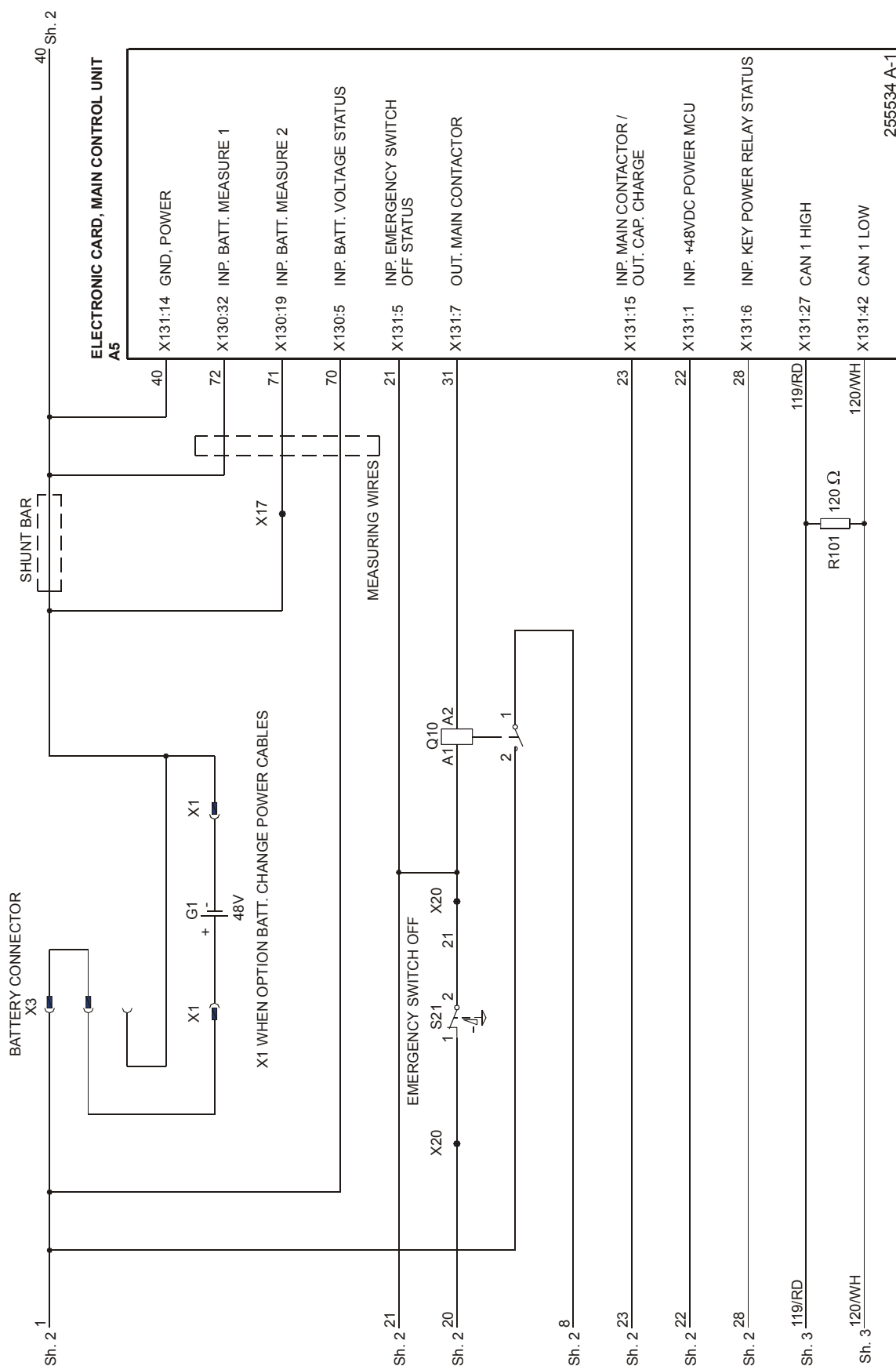
Overview

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19.2 Overview

TBD

19.3 Wiring diagrams



Wiring diagrams

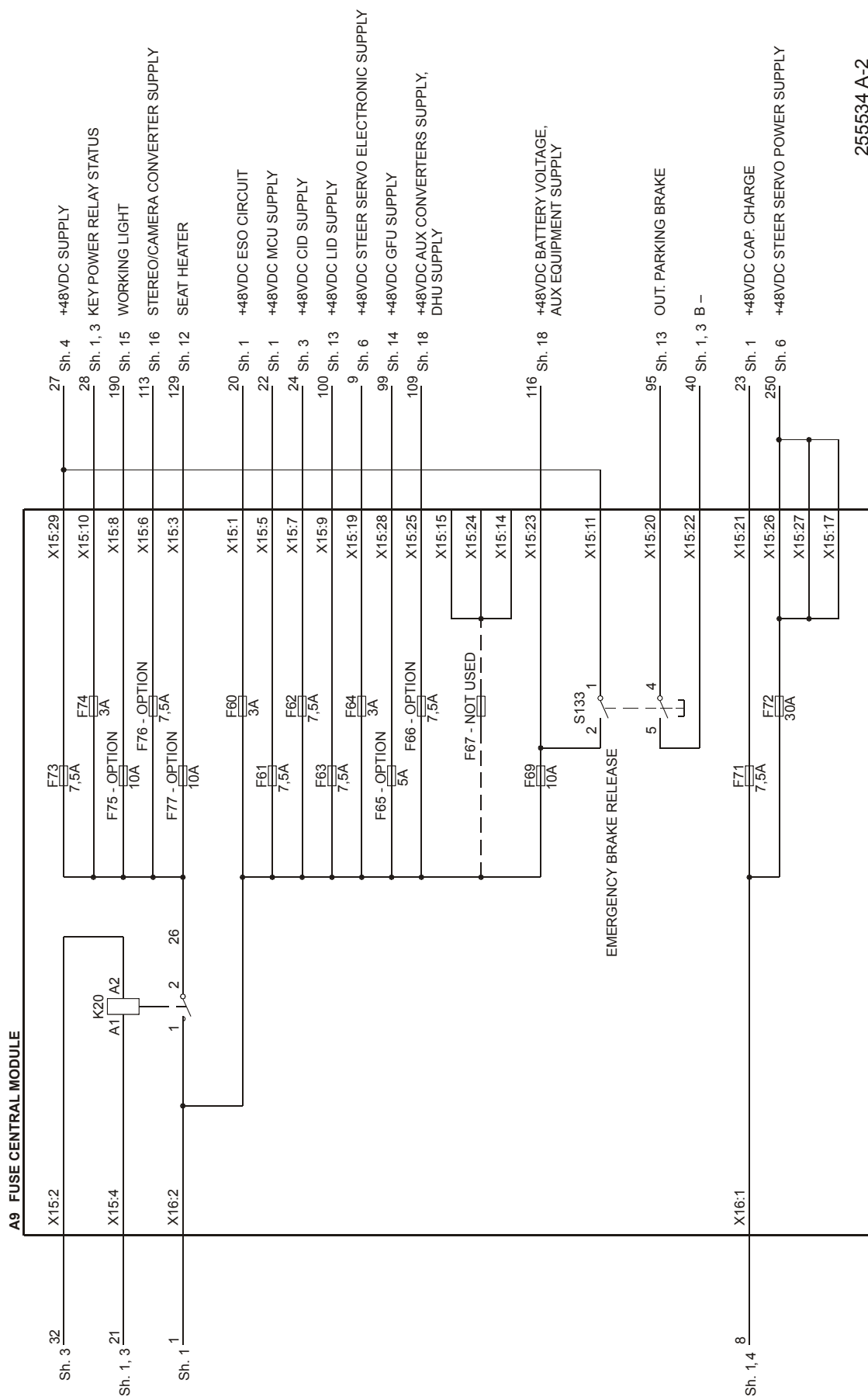
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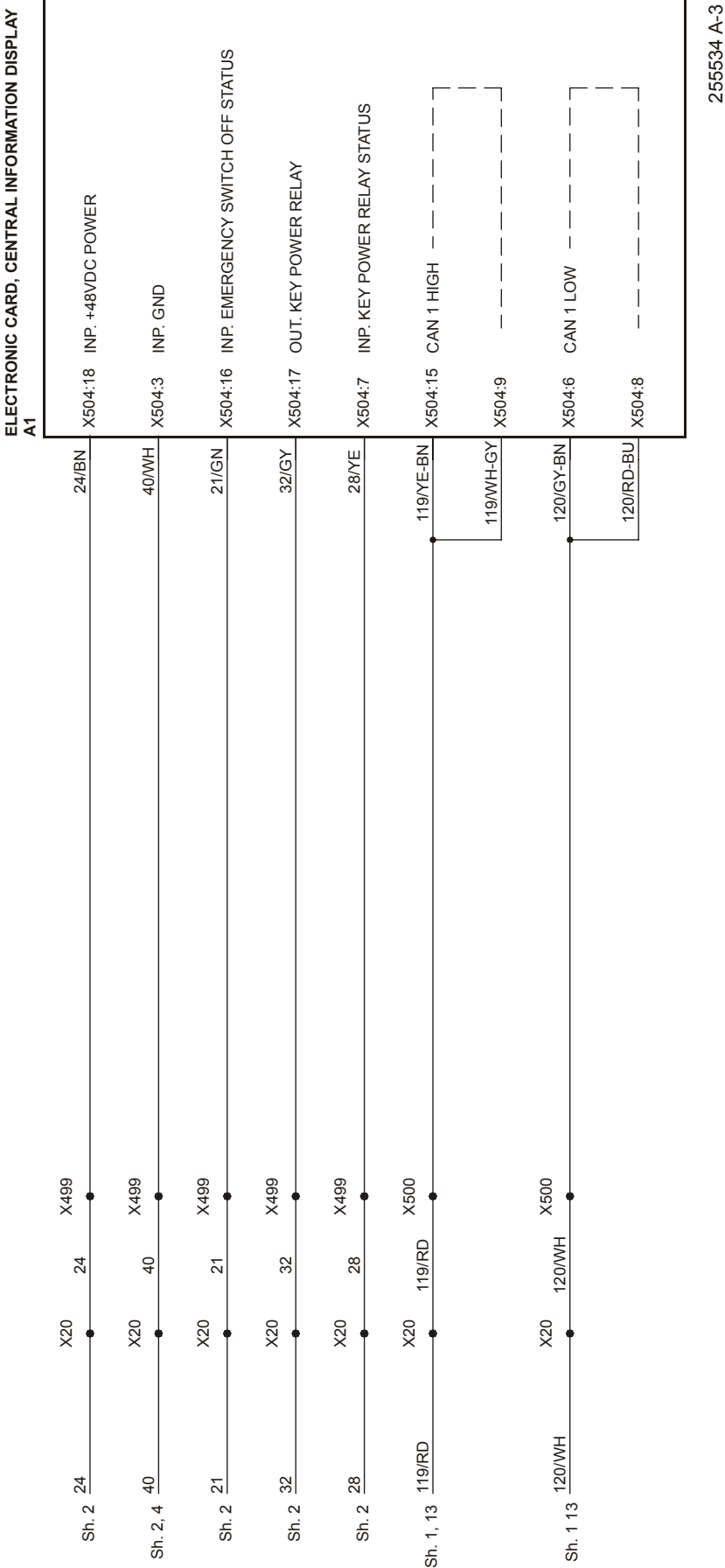
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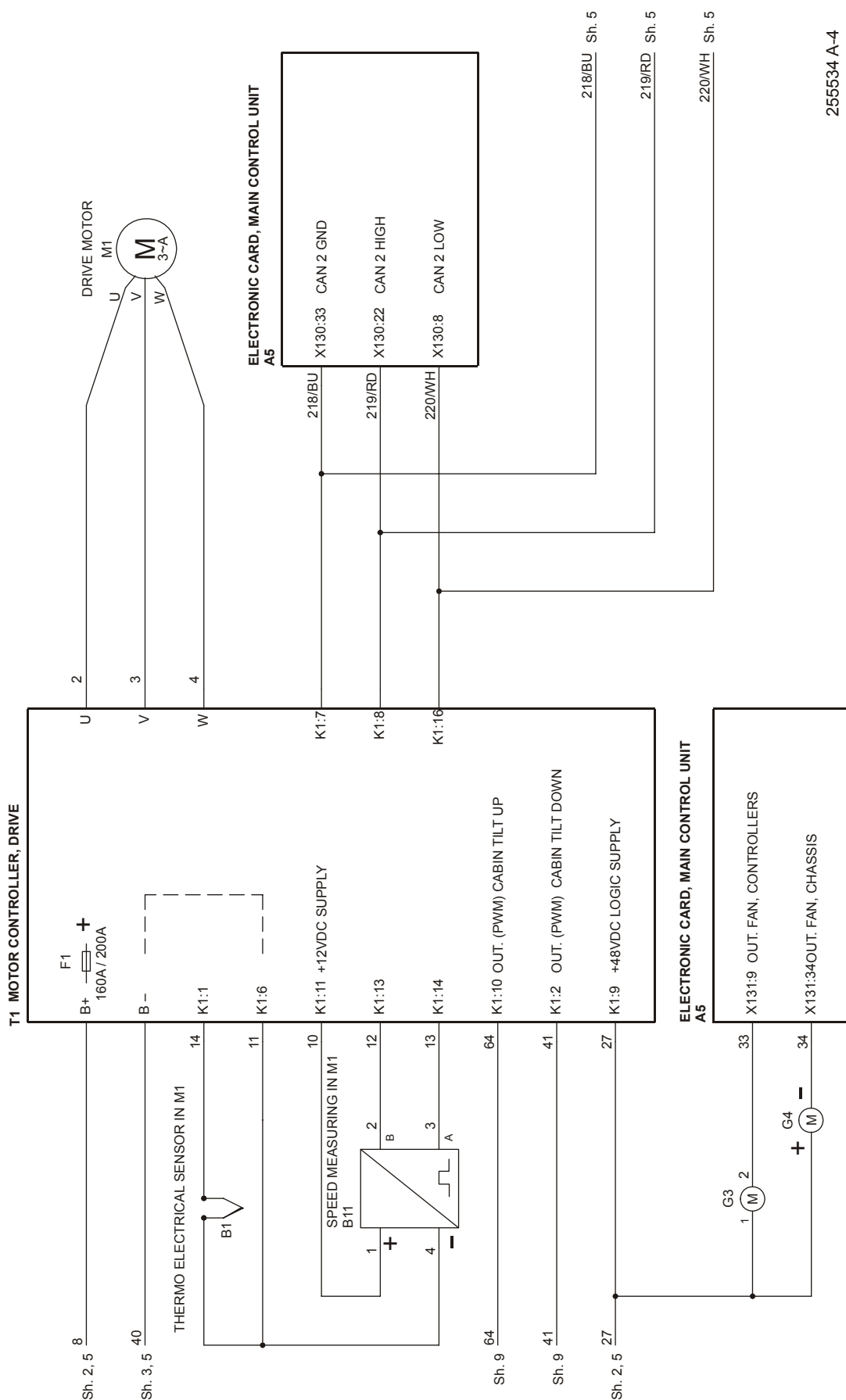
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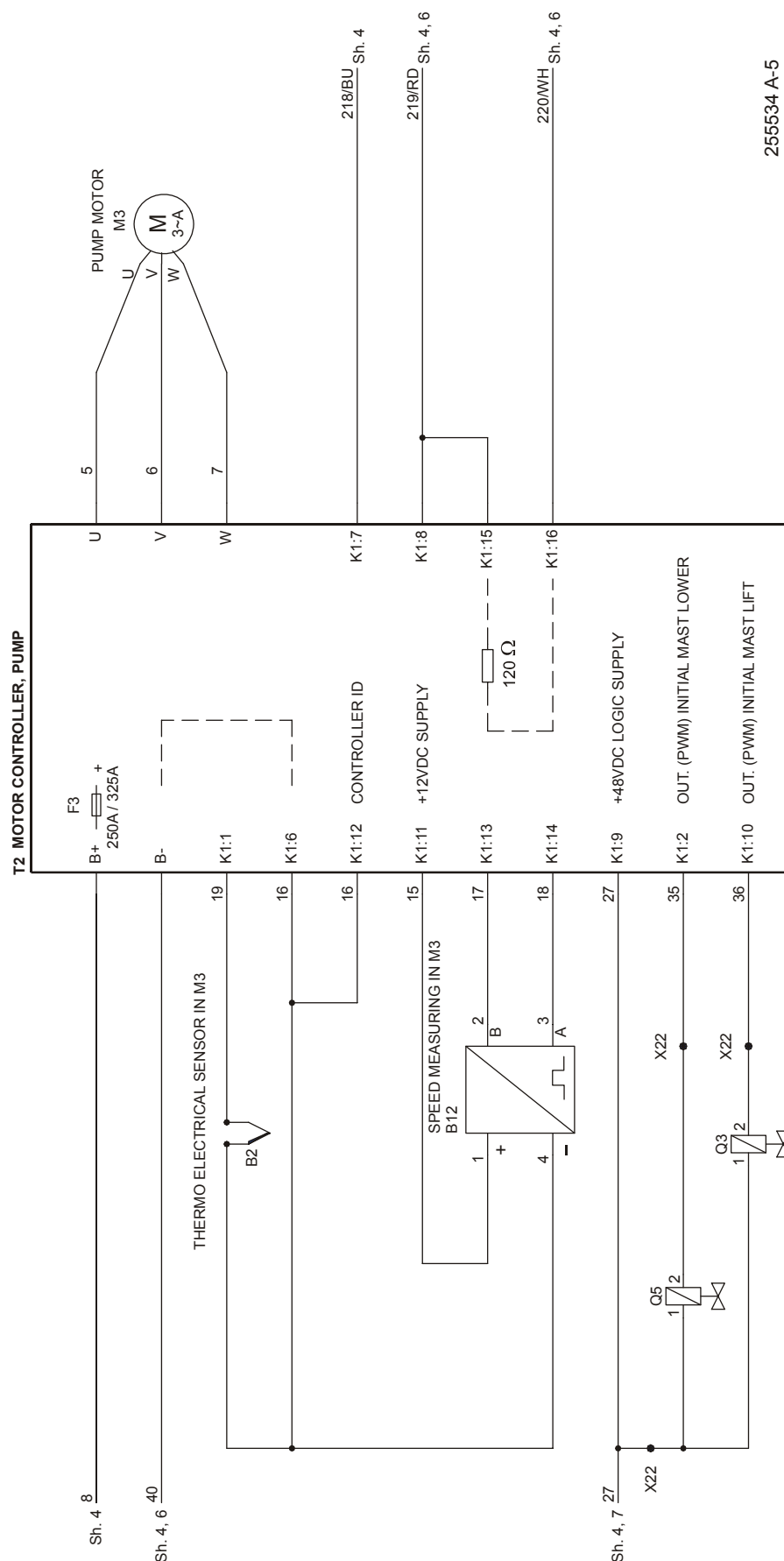
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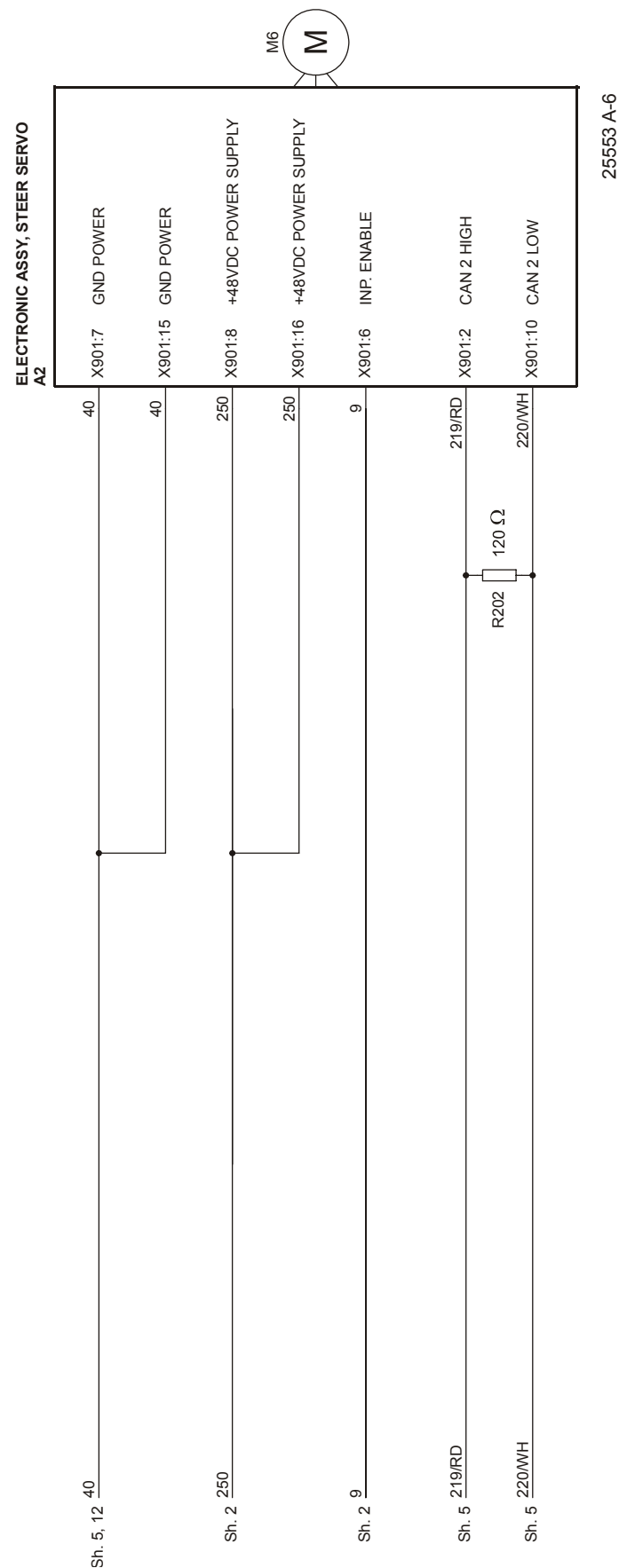


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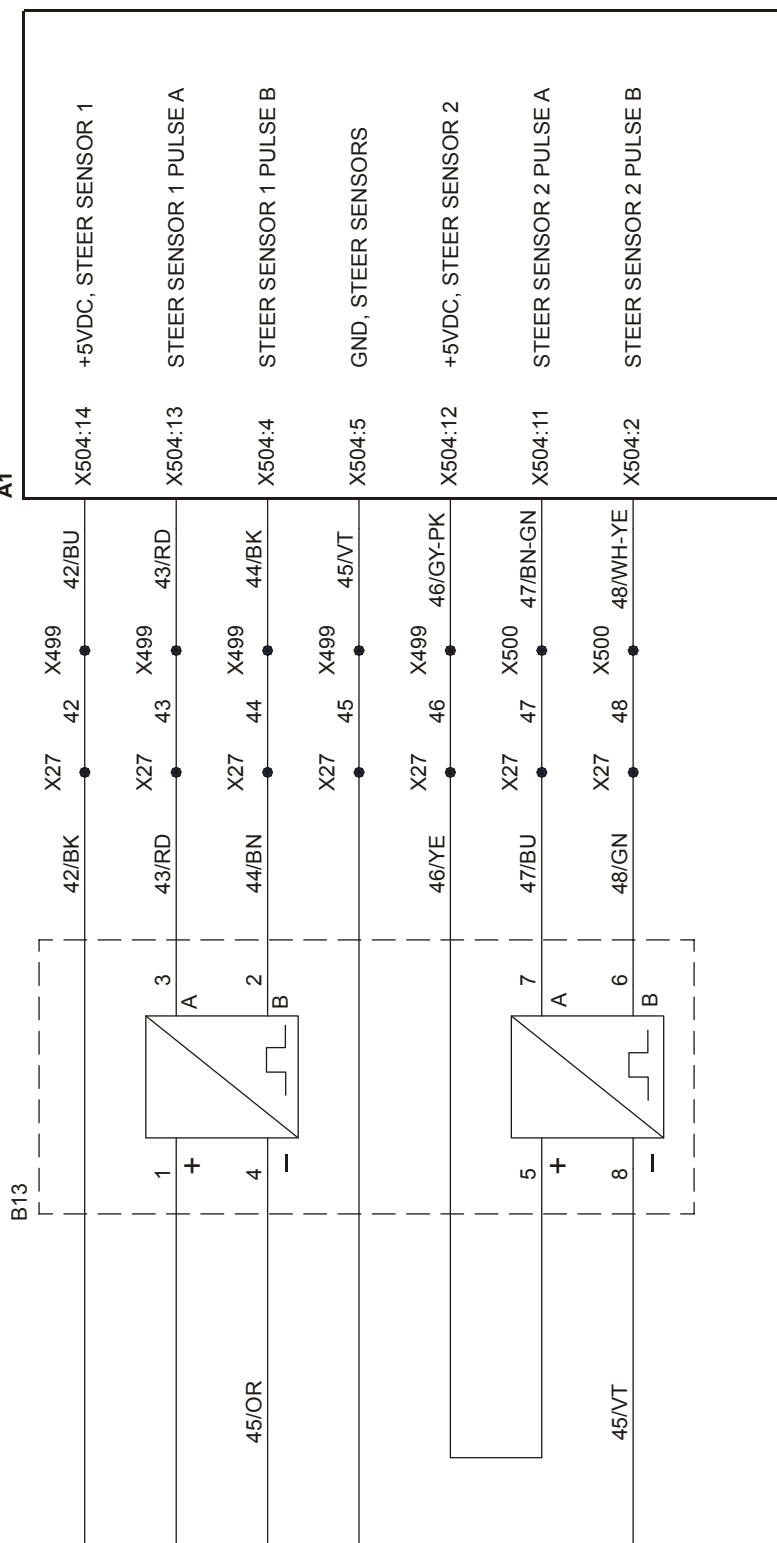
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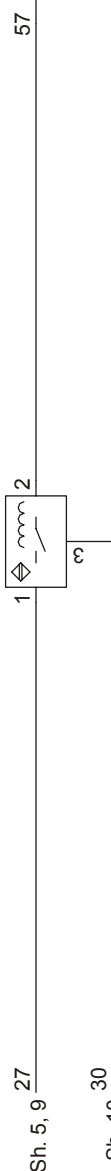
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ELECTRONIC CARD, MAIN CONTROL UNIT A5



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Wiring diagrams

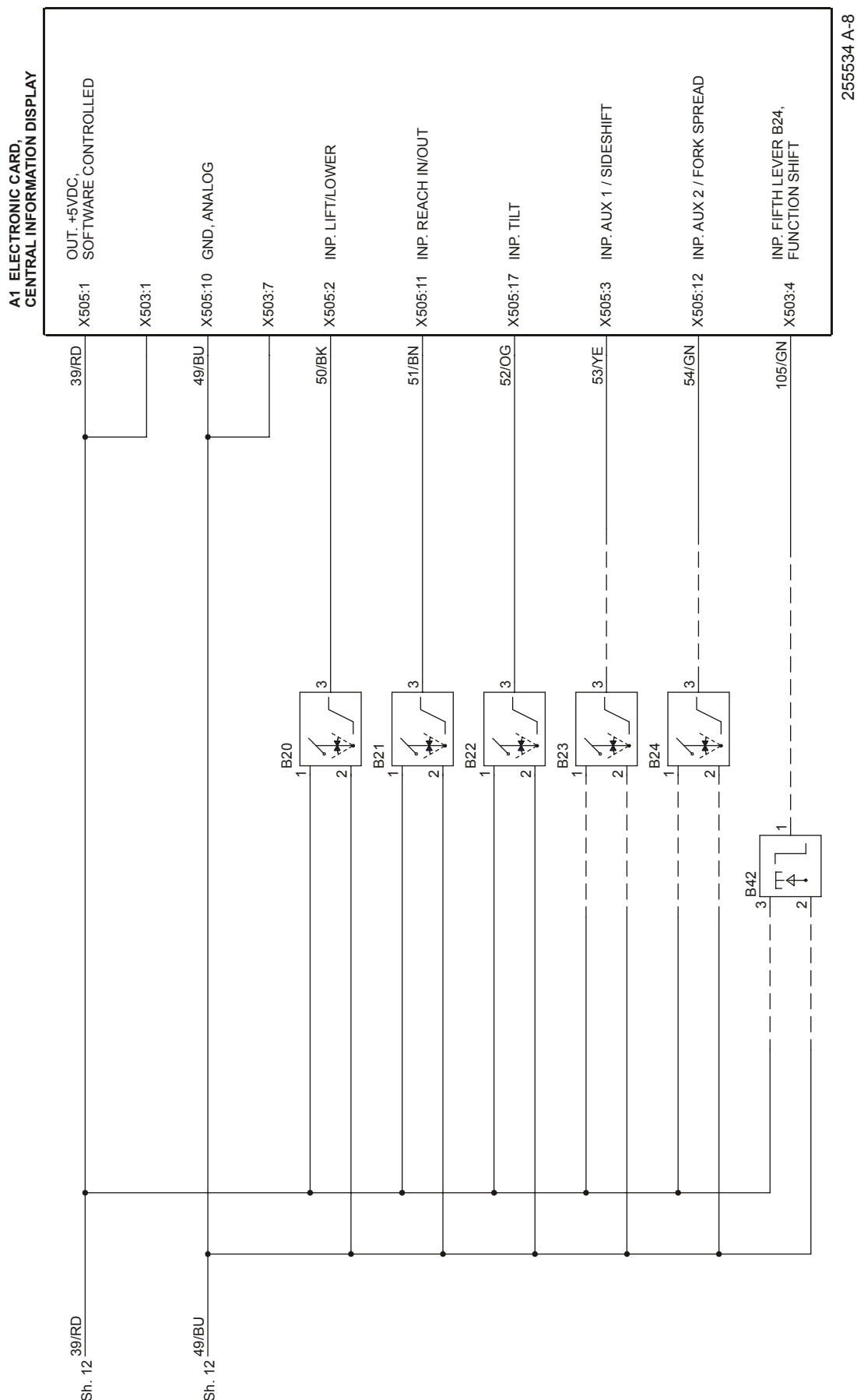
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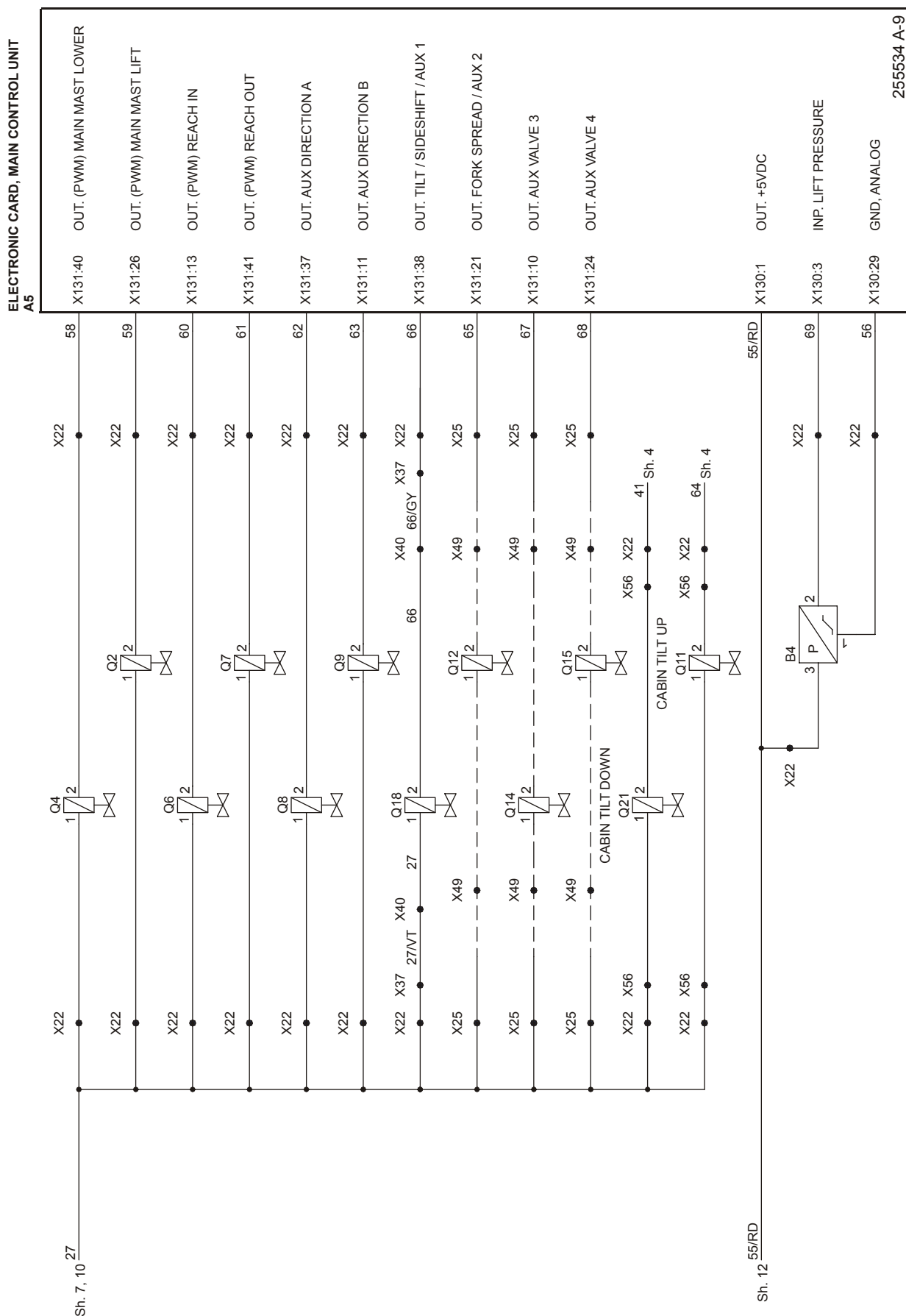


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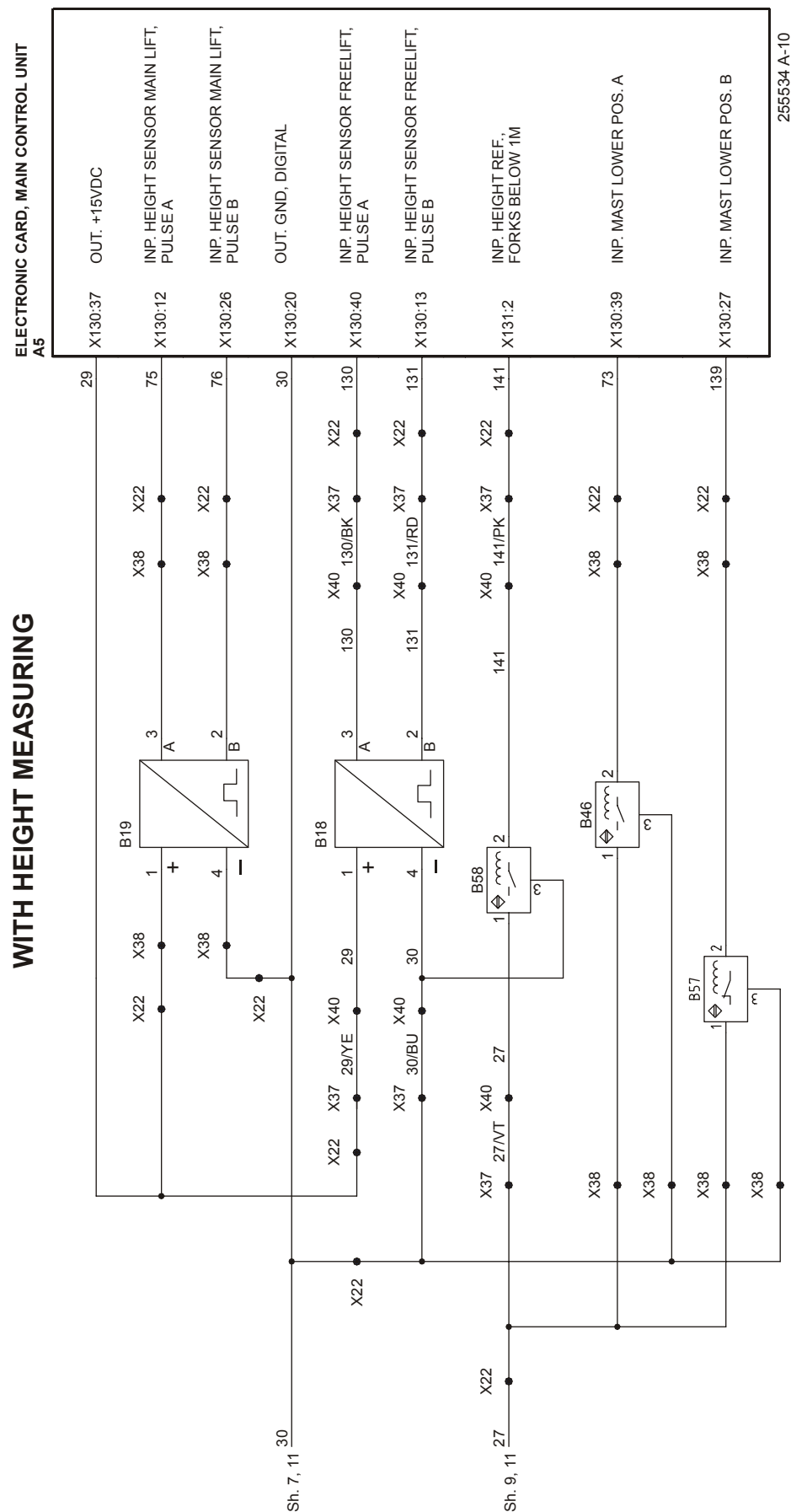
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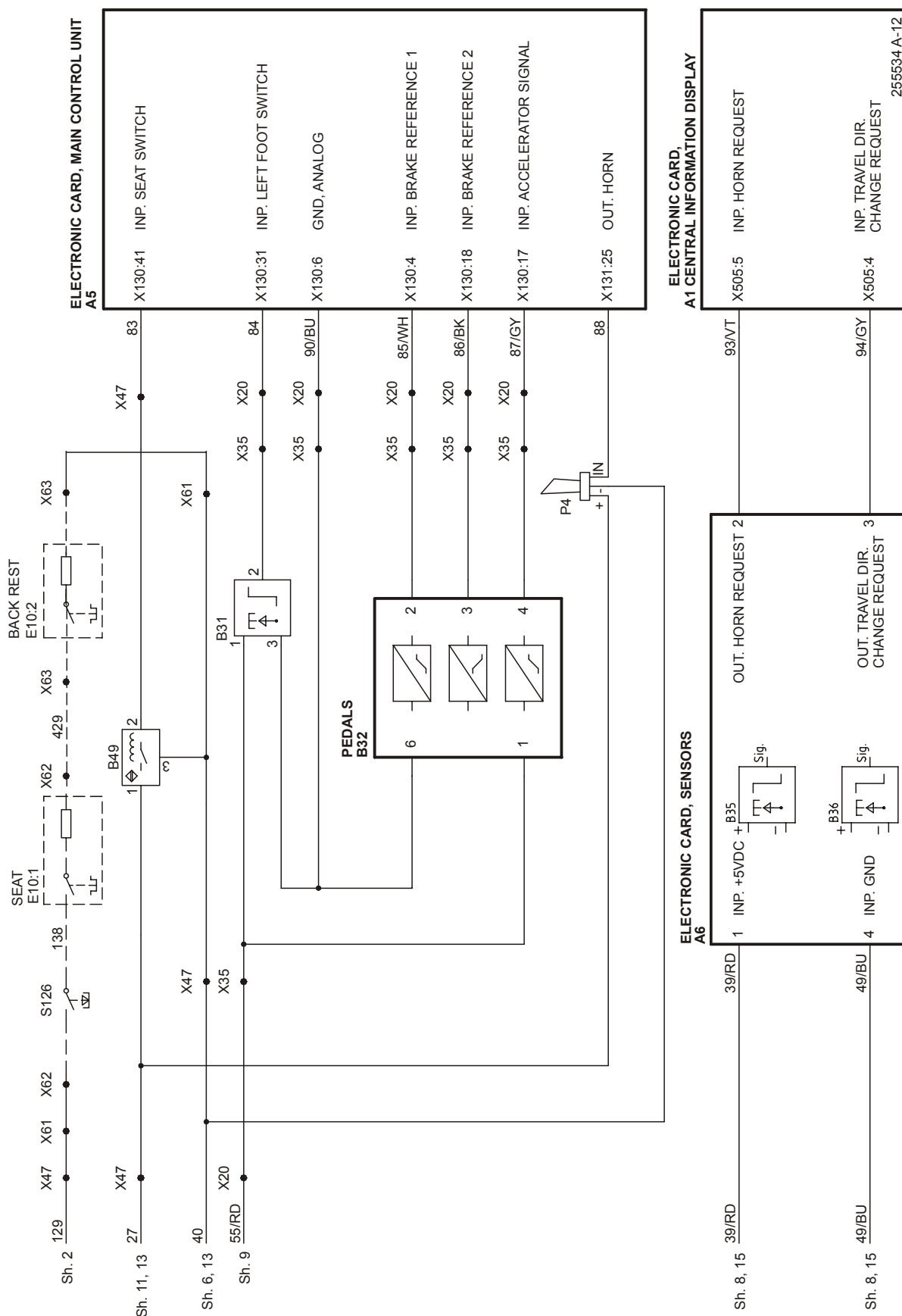
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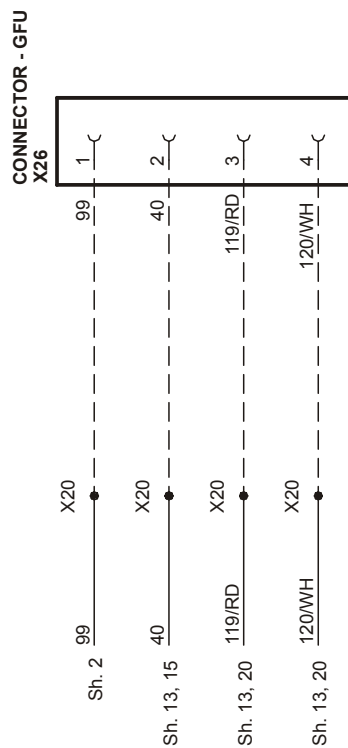




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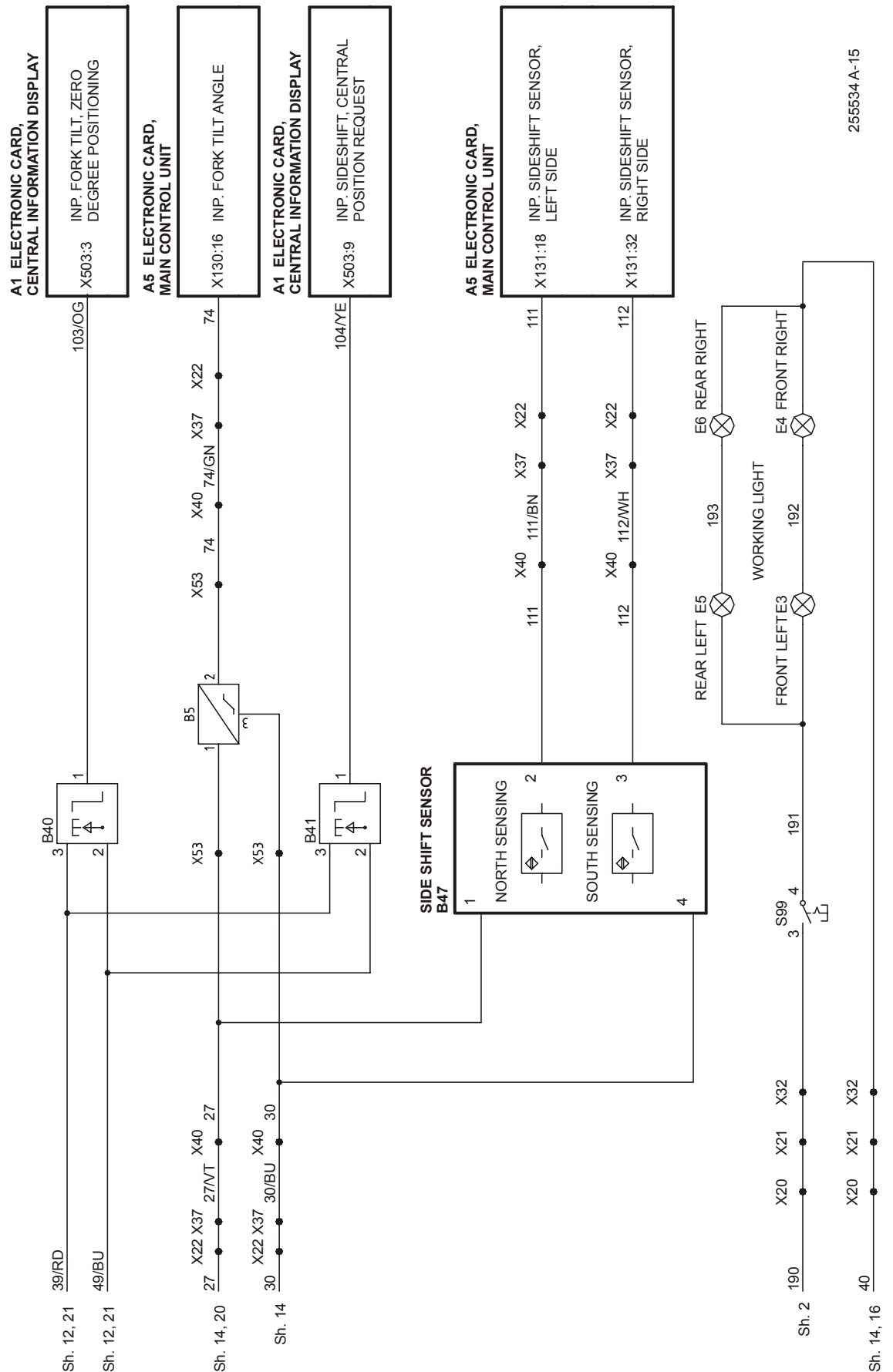
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OPTION



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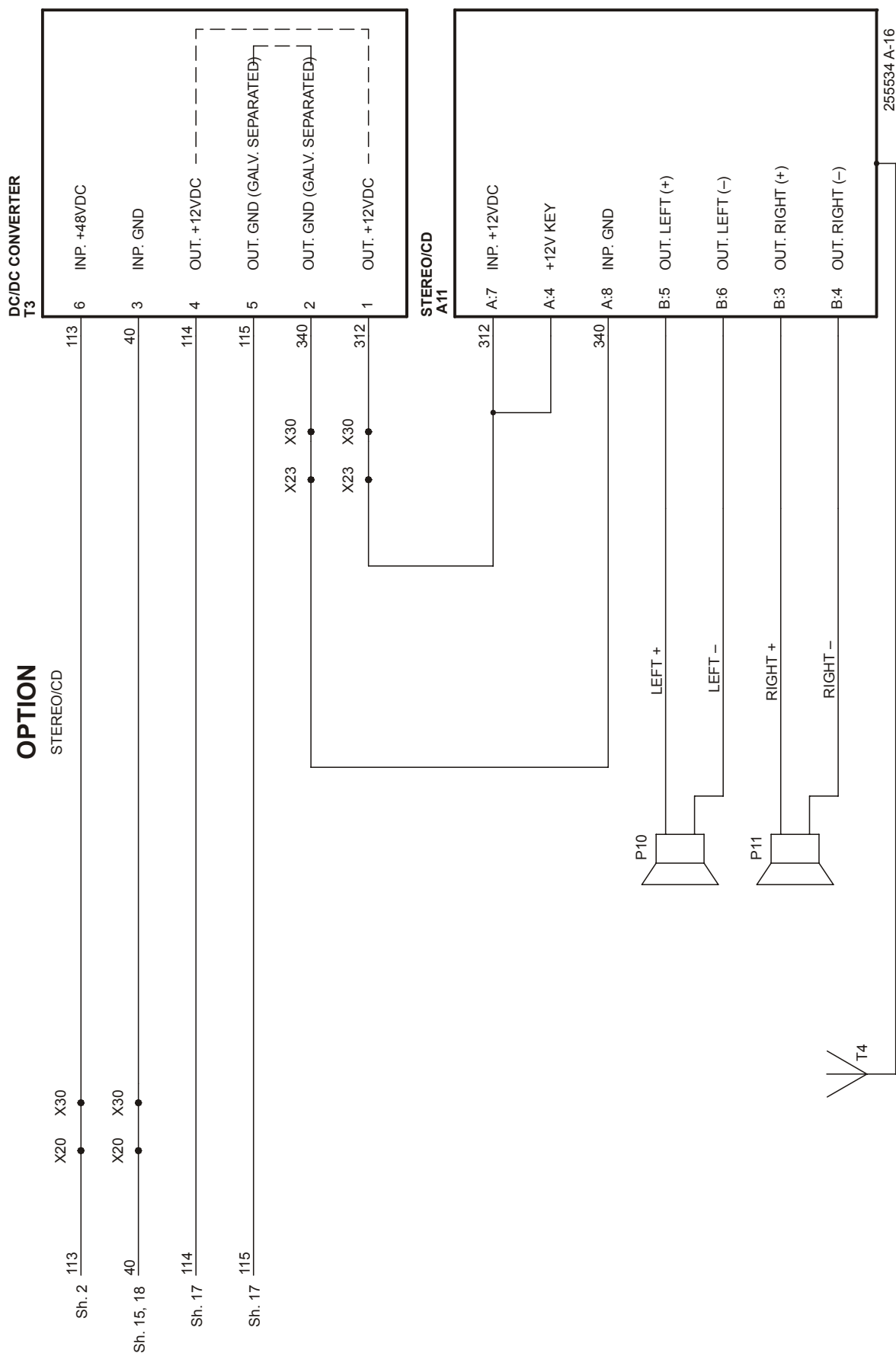
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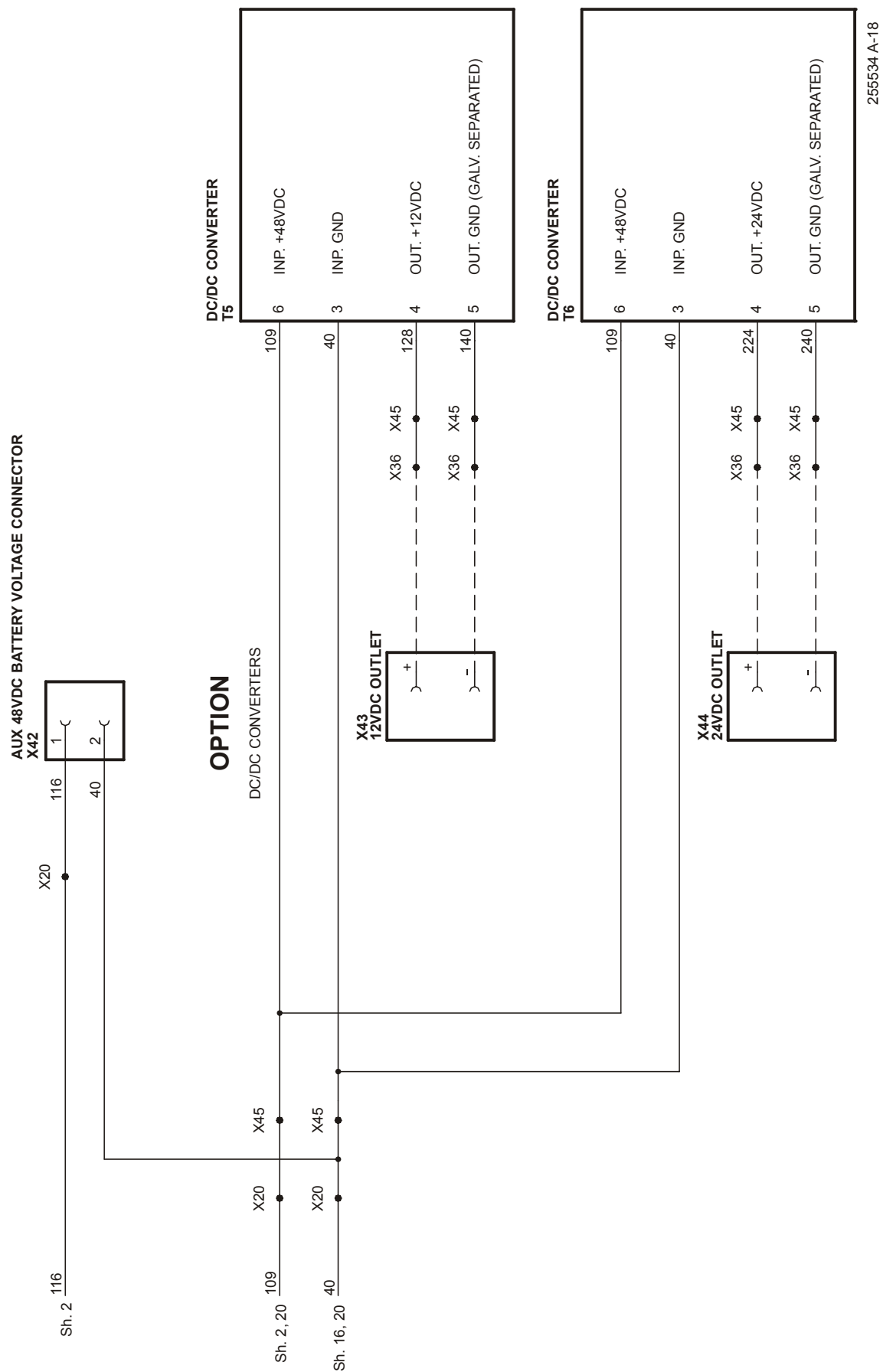




Wiring diagrams

Wiring diagrams

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OPTION

ELECTRONIC START KEY

ELECTRONIC START KEY
K1

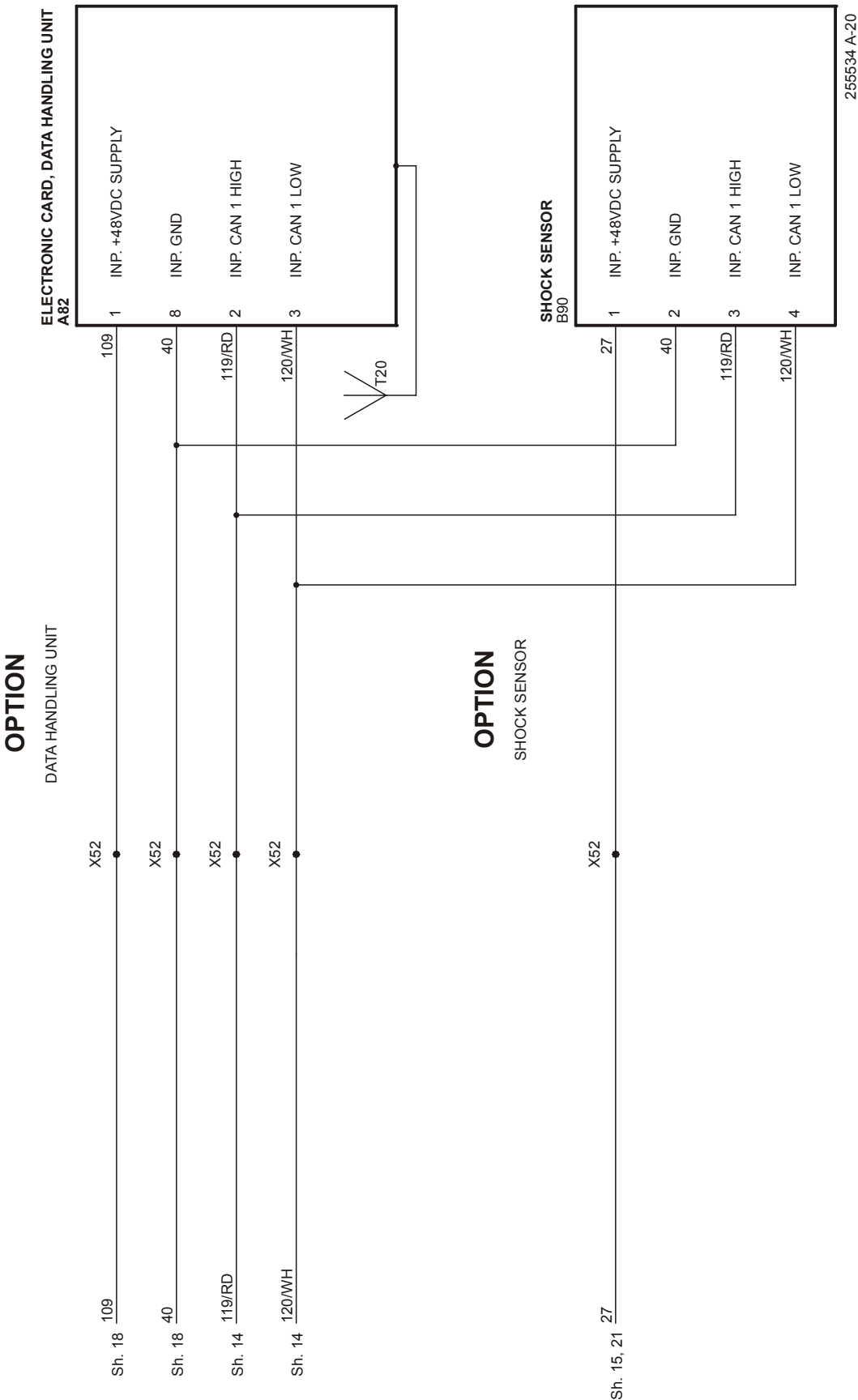
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2	133/WK-BK	X506:2	OUT. GND
3	134/WH-BN	X506:3	OUT. ENABLE
4	135/WH-RD	X506:4	OUT. SCK (SPI CLOCK)
5	136/WH-OG	X506:5	INP. MISO (SPI DATA MASTER IN)
6	137/WH-YE	X506:6	OUT. MOSI (SPI DATA MASTER OUT)

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Wiring diagrams

Wiring diagrams

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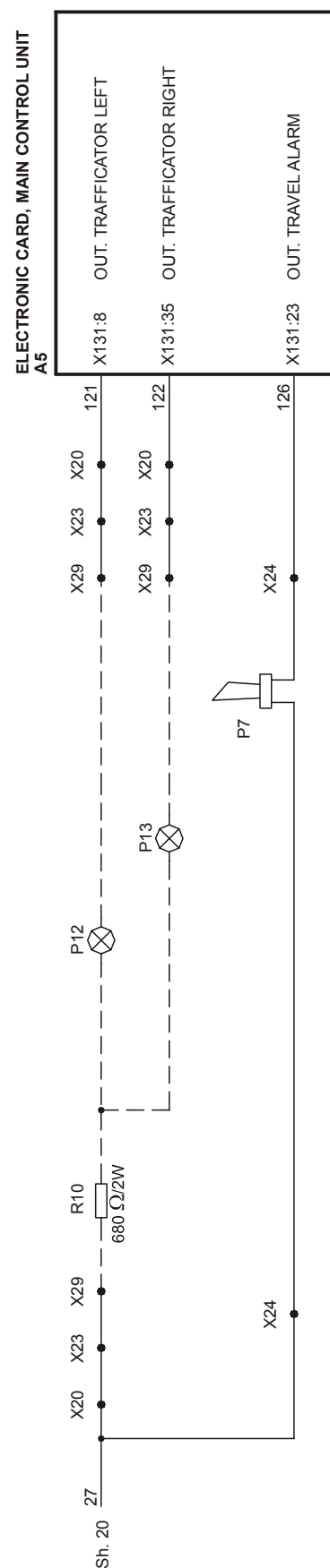
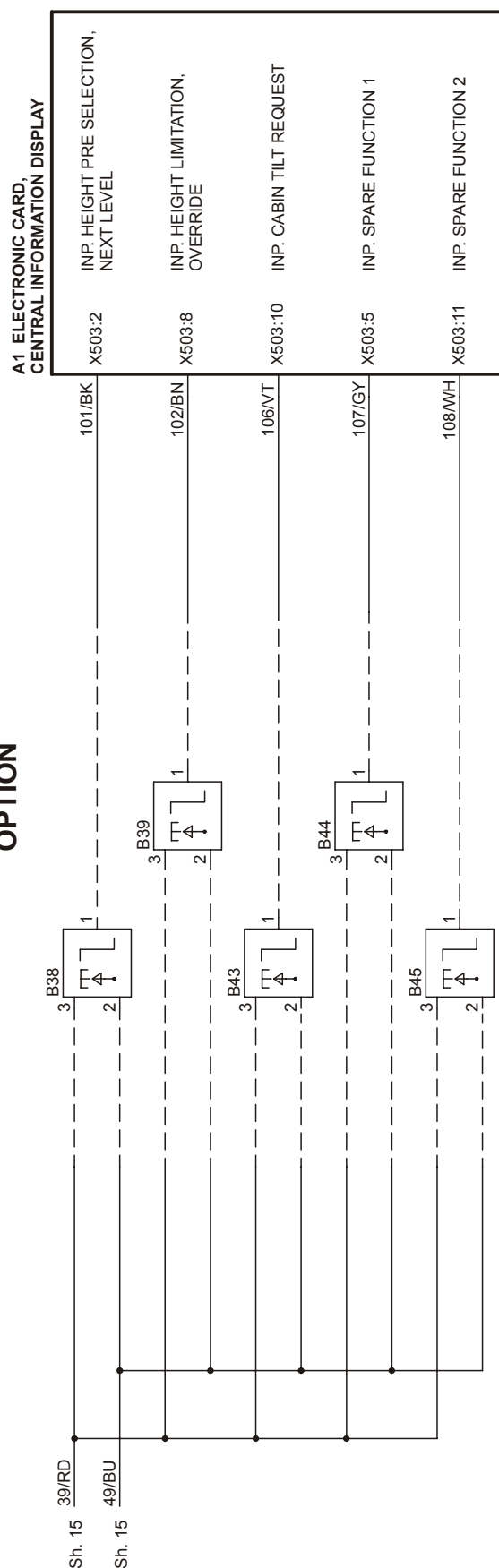
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Wiring diagrams

Wiring diagrams

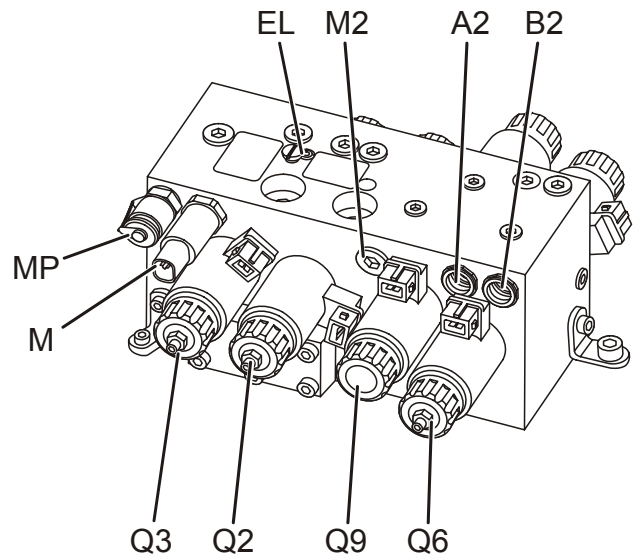
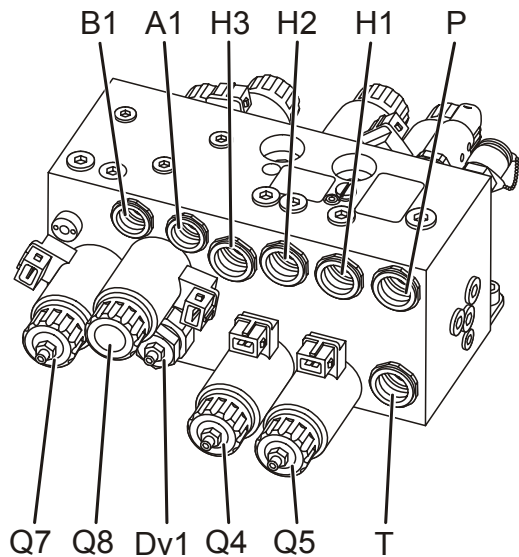
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20 – Hydraulics schematics

20.1 Main valve

20.1.1 RRE Std.



A1	Extra function
A2	Extra function
B1	Extra function
B2	Extra function
Dv1	Main pressure limiter 25 MPa (250 bar)
EL	Emergency lowering
H1	Free lift (initial lift)
H2	Main lift
H3	Main lift
M	Pressure sensor H1
M2	Measuring point H2-H3

MP	Meter outlet, pump pressure P
P	Pump connection
Q2	Lift valve, main lift
Q3	Lift valve, free lift (initial lift)
Q4	Lowering valve, main lift
Q5	Lowering valve, free lift (initial lift)
Q6	Reach carriage - In
Q7	Reach carriage - Out
Q8	Extra function, pump pressure for A1
Q9	Extra function, pump pressure for B1
T	Tank connection

Hydraulics schematics

Main valve

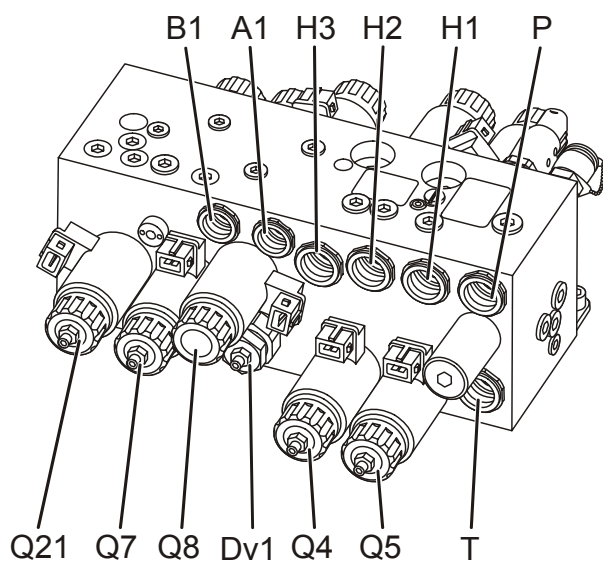
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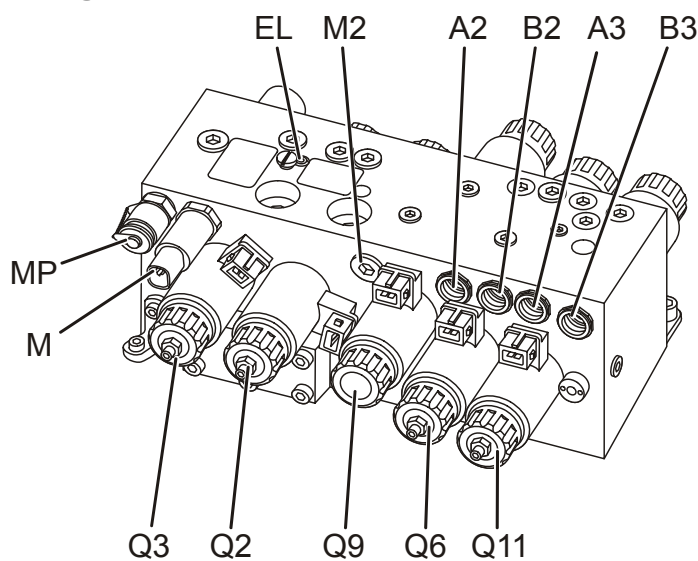
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20.1.2 RRE Ergo



- A1 Extra function
- A2 Extra function
- A3 Cabin tilt - down
- B1 Extra function
- B2 Extra function
- B3 Cabin tilt - up
- Dv1 Main pressure limiter 25 MPa (250 bar)
- EL Emergency lowering
- H1 Free lift (initial lift)
- H2 Main lift
- H3 Main lift
- M Pressure sensor H1
- M2 Measuring point H2-H3



- MP Meter outlet, pump pressure P
- P Pump connection
- Q2 Lift valve, main lift
- Q3 Lift valve, free lift (initial lift)
- Q4 Lowering valve, main lift
- Q5 Lowering valve, free lift (initial lift)
- Q6 Reach carriage - In
- Q7 Reach carriage - Out
- Q8 Extra function, pump pressure for A1
- Q9 Extra function, pump pressure for B1
- Q11 Cabin tilt - up
- Q21 Cabin tilt - down - and emergency lowering
- T Tank connection

20.2 Hydraulics schematics

20.2.1 Schematics designations

Designation	Function	Component type
Dv1	Main pressure limitation	Valve
Dv2	Reach pressure limitation	Valve
Dv3	Cabin tilt pressure limitation (Ergo)	Valve
M	Pressure sensor, free lift (initial lift)	Sensor
M2	Measuring point, main lift	Input/output
M3	Pump motor	Motor
MP	Meter outlet pump pressure	Outlet
P	Pump	Pump
Q2	Main mast lift	Magnetic valve
Q3	Free lift lifting (initial mast)	Magnetic valve
Q4	Main mast lowering	Magnetic valve
Q5	Free lift lowering (initial mast)	Magnetic valve
Q6	Reach carriage - in	Magnetic valve
Q7	Reach carriage - out	Magnetic valve
Q8	Extra function, direction A	Magnetic valve
Q9	Extra function, direction B	Magnetic valve
Q11	Cabin tilt - upwards	Magnetic valve
Q21	Cabin tilt - downwards	Magnetic valve
T	Tank	Tank

Hydraulics schematics

Hydraulics schematics







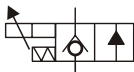
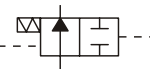
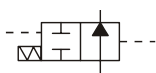

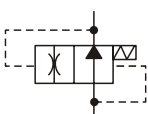
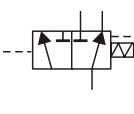
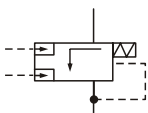
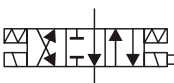
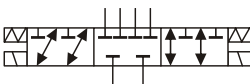

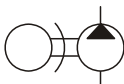




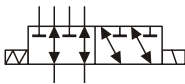
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20.2.2 List of symbols

Symbol	Description	Symbol	Description
	Single-acting cylinder		Double-acting cylinder
	Shuttle valve		Pressure sensor, analog
	Choke		Shut-off valve for emergency lowering
	Proportional valve, electro-magnetically controlled		Pressure compensation valve
	Shunt valve		Pressure limiting valve
	Flow control valve		Priority flow valve
	Counter balance valve (above centre valve)		Directional valve 4/3
	Directional valve 6/3		Proportional valve 4/3
	Electric motor and pump		Filter
	Tank		Non-return valve
	Counter balance valve		Directional valve 6/2

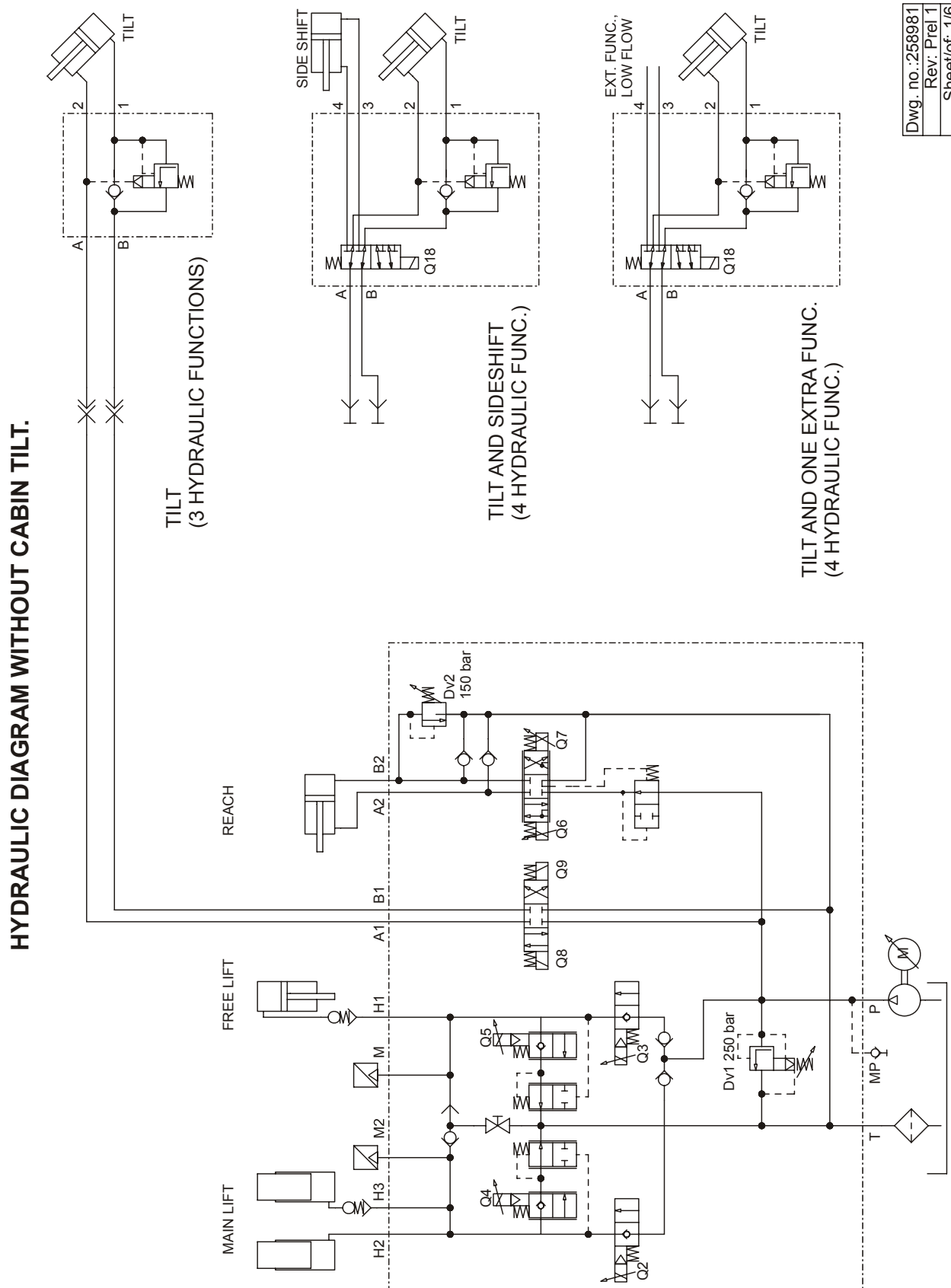
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20.2.3 Wiring diagrams RRE/RRE Ergo



Hydraulics schematics

Hydraulics schematics

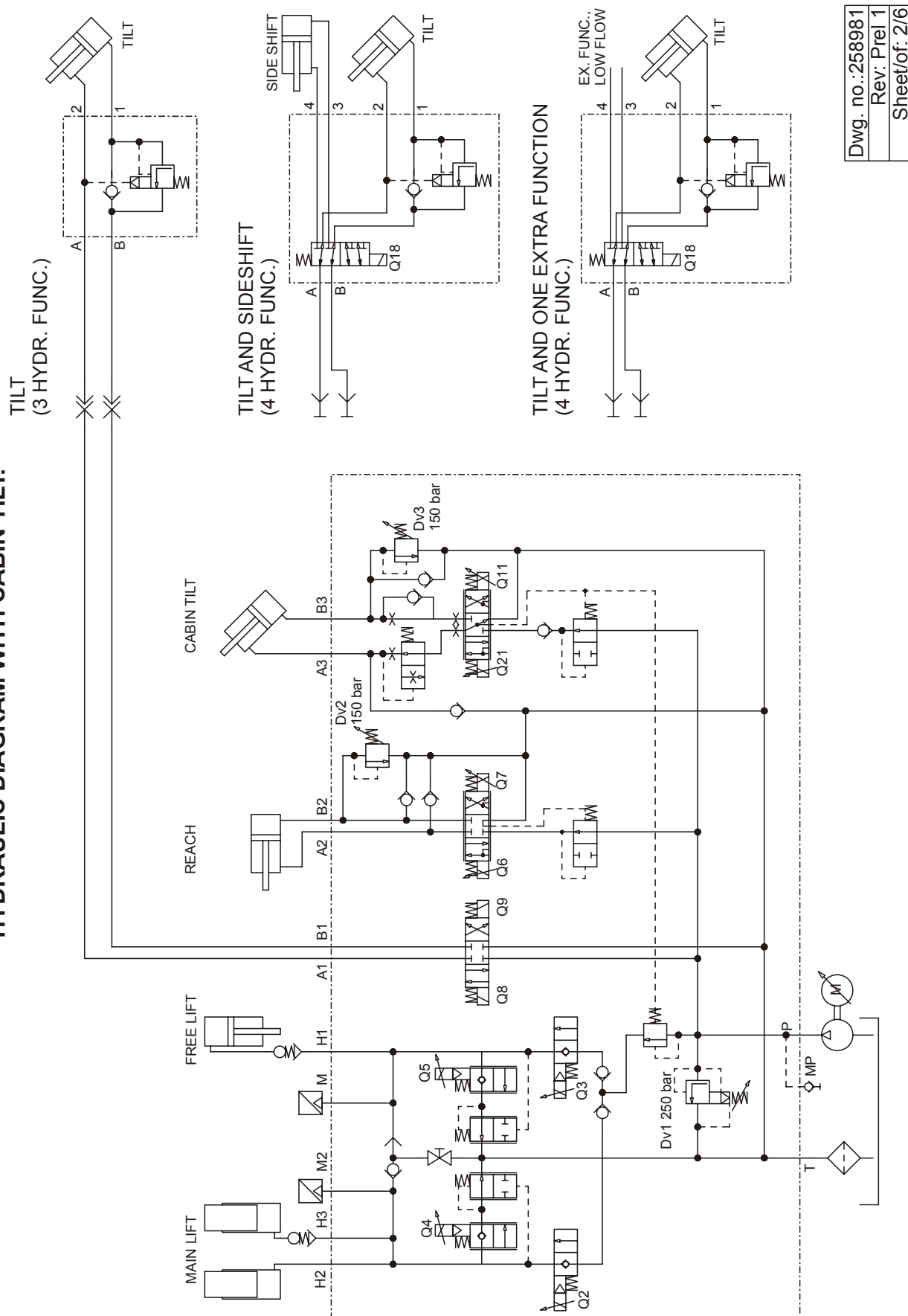
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HYDRAULIC DIAGRAM WITH CABIN TILT.

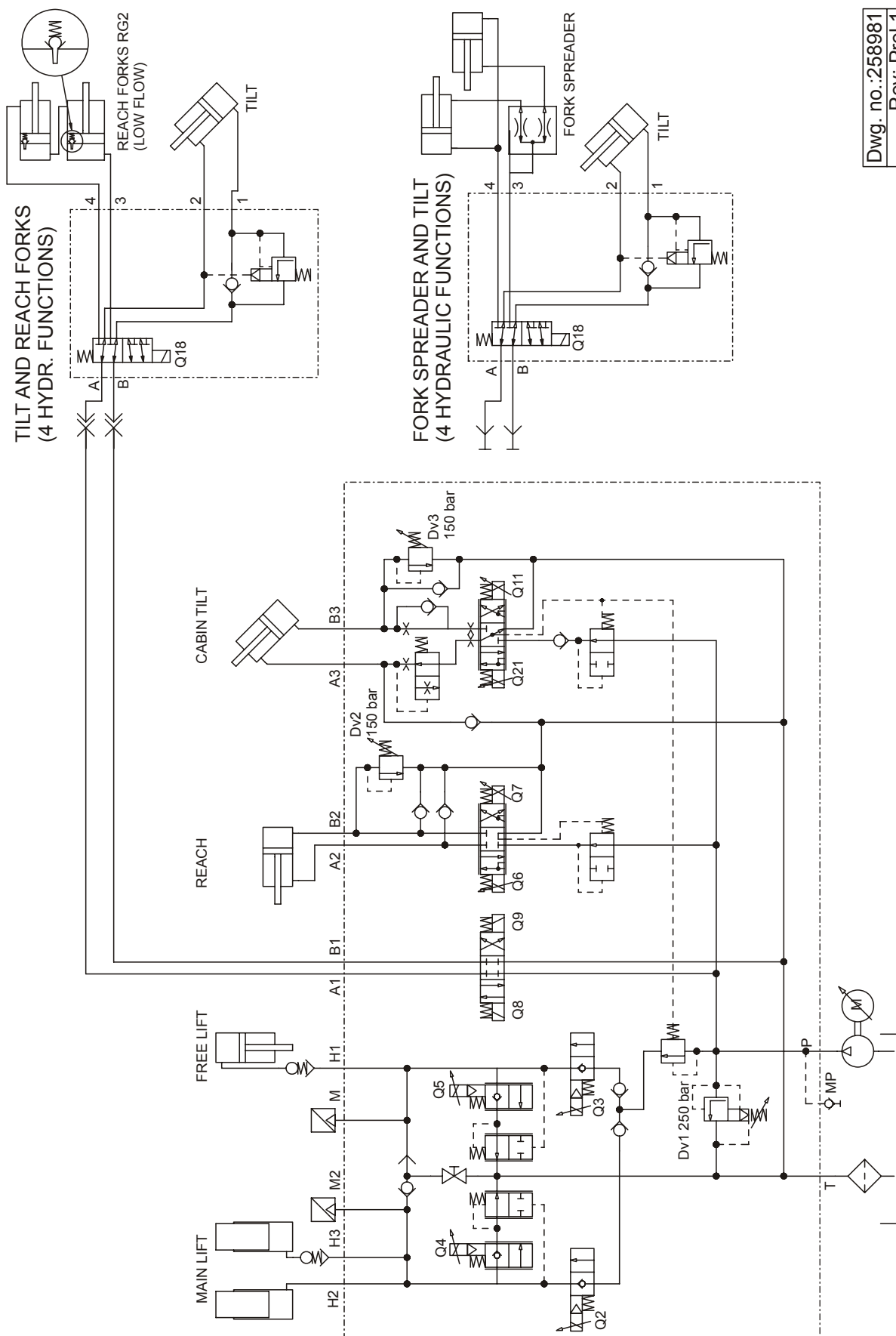


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Hydraulics schematics

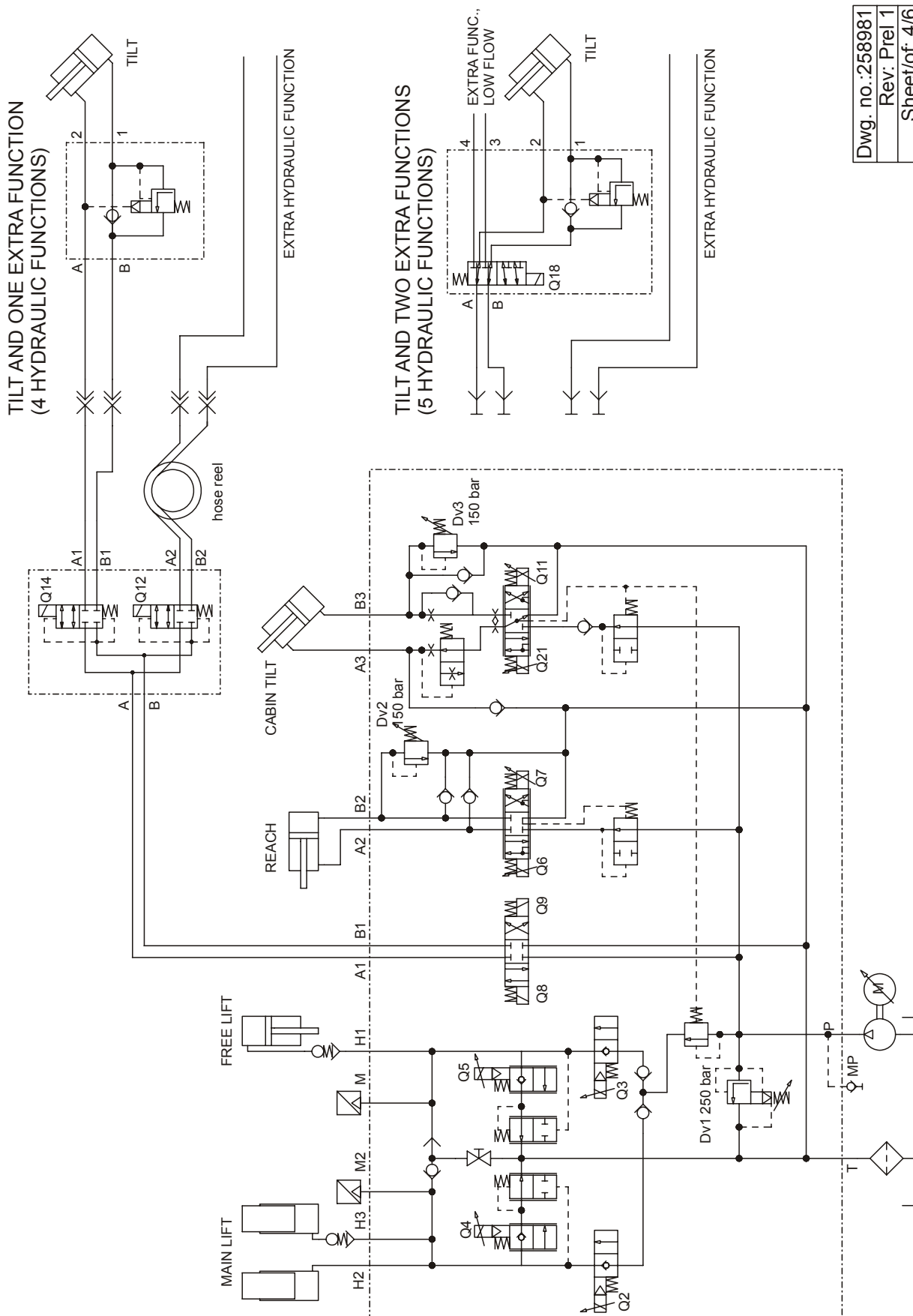
Hydraulics schematics

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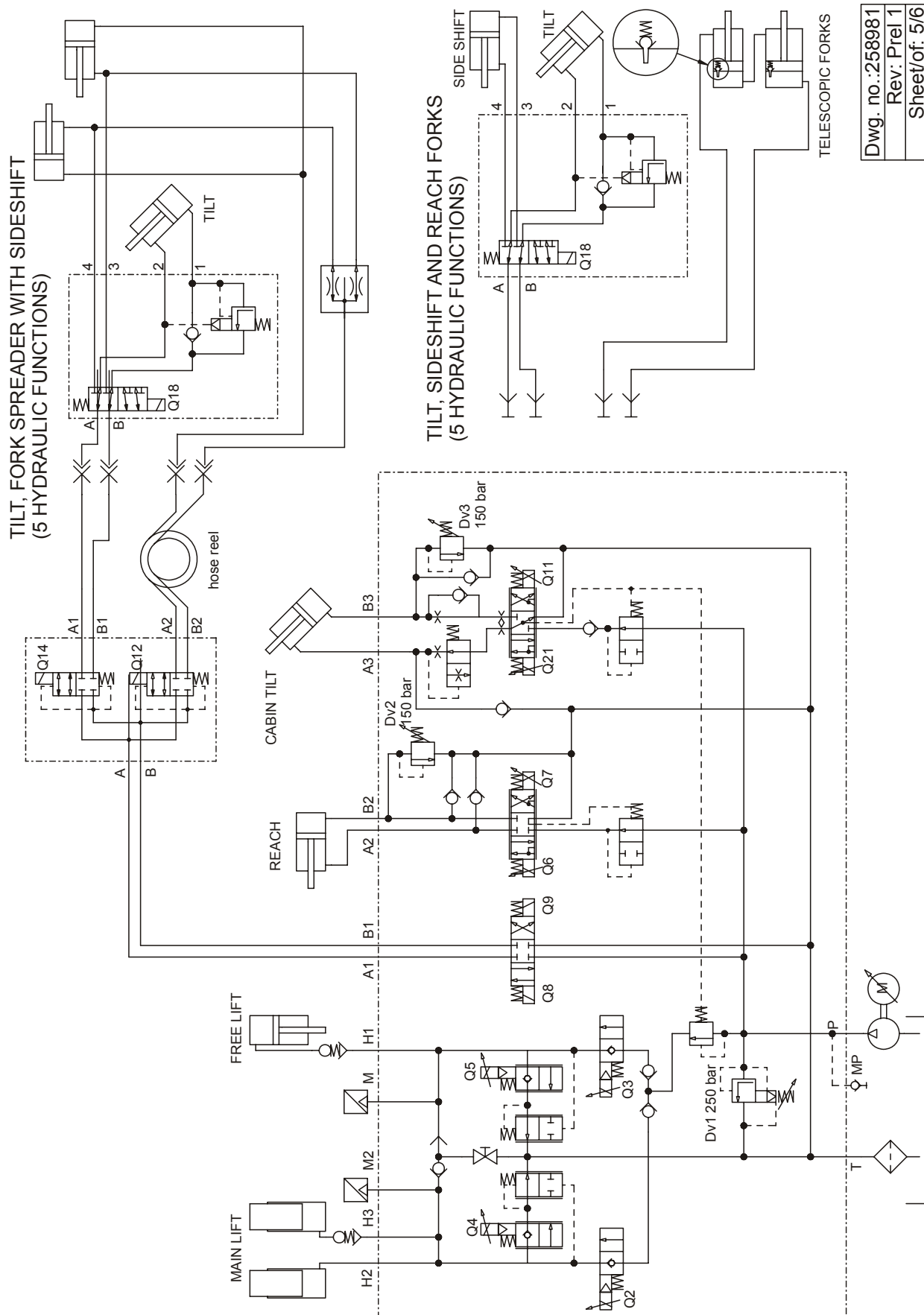
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Hydraulics schematics

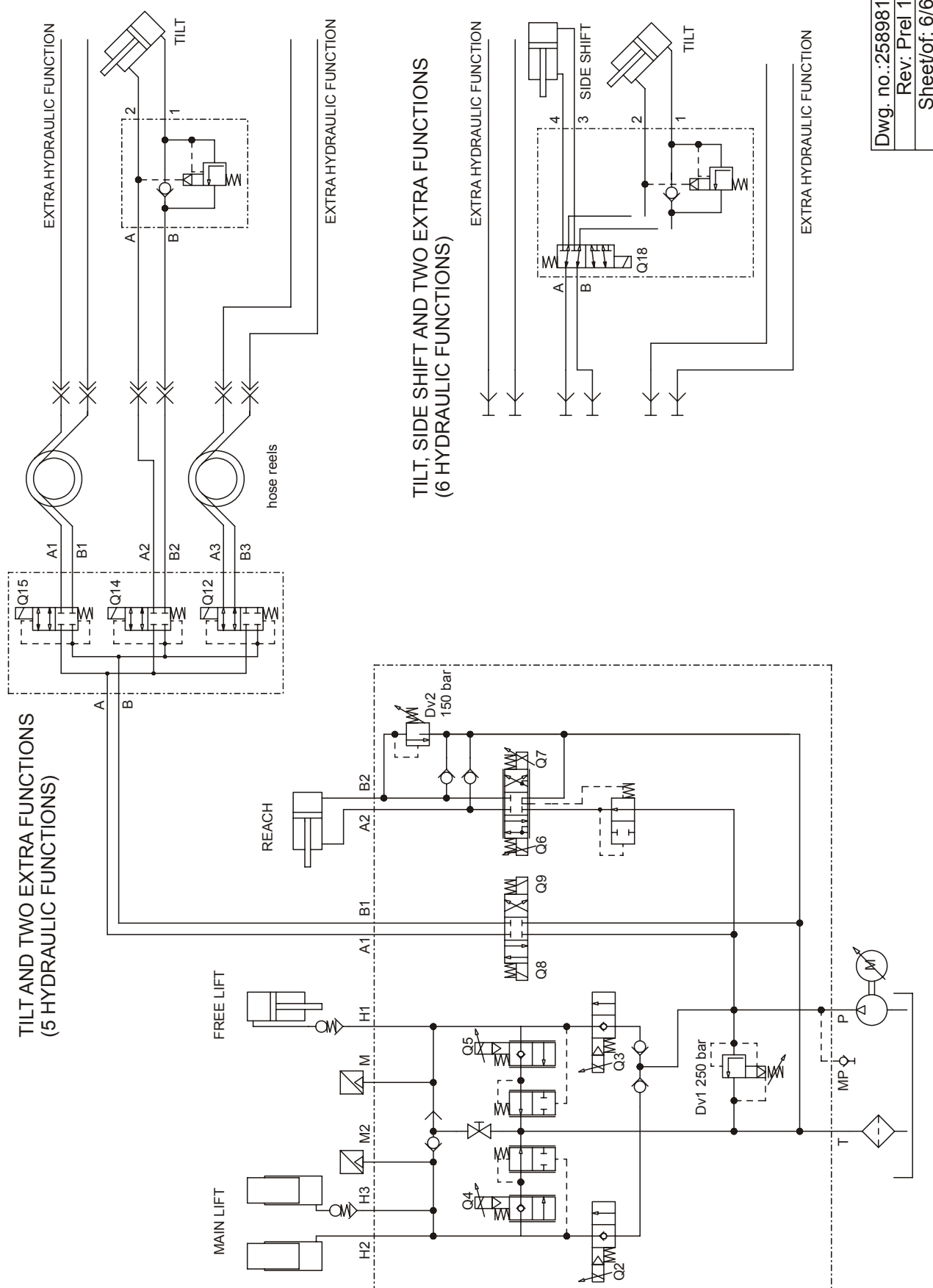
Hydraulics schematics

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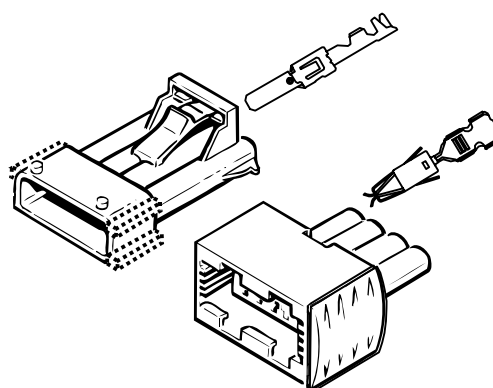
21 – Tool

21.1 AMP connectors

PT = Power Timer (4.8, 5.8, 6.3 mm)

JPT = Junior Power Timer (2.8 mm)

MPT = Micro Power Timer (1.5 mm)



Tool	Number	Use
	151080 (PT)	Tool for removing pins/sleeves
	213296 (JPT)	Tool for removing pins/sleeves
	213298 (MPT)	Tool for removing pins/sleeves
	1=163787 (JPT) 2=163788 (JPT) 1=213336 (MPT) 2=213337 (MPT)	Tool for fitting sleeves
	1=213336 (JPT) 2=213549 (JPT)	Tool for fitting pins For 0.5–2.5 mm ²

Tool

AMP microtimer

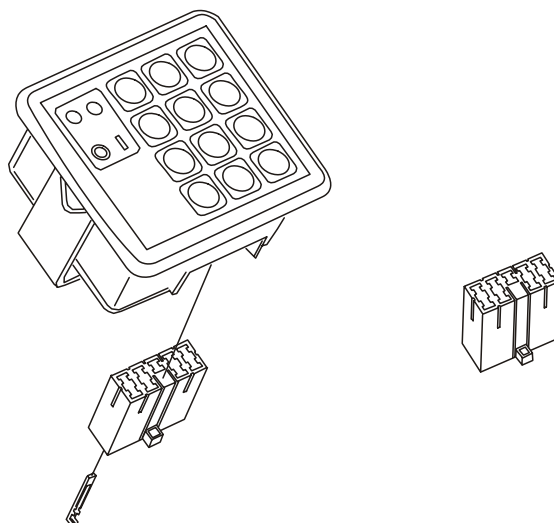
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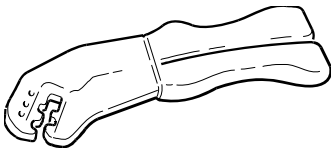
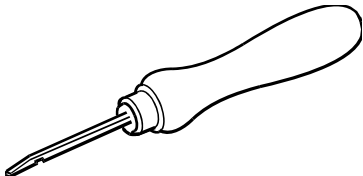
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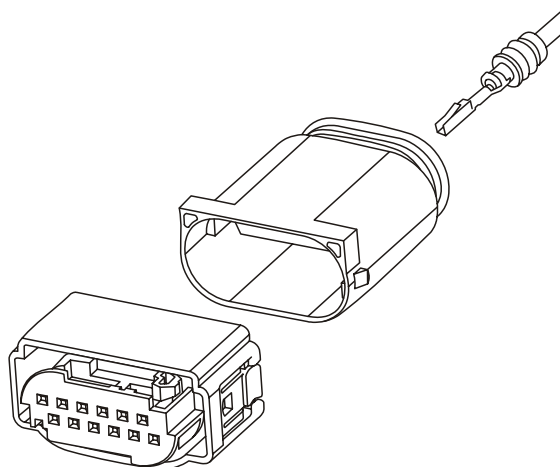
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21.2 AMP microtimer



Tool	Number	Use
	141199	Tool for fitting pins/sleeves
	650006	Tool for removing pins/sleeves

21.3 MQS contacts



Tool	Number	Use
<p>The diagram shows an open toolbox. The lid is on the left, and the base is on the right. Inside the base, there are two pairs of pliers. The lid contains several compartments, each holding a different type of connector or sleeve.</p>	257841	<p>MQS Basic toolbox.</p> <p>The box contains:</p> <ul style="list-style-type: none"> 1 pair of pliers with tools 25 jointing sleeves 0.5–1.5 mm² 2 each of 2-, 3-, 4-, 6-, 8- and 12-pole connector pairs (male and female) with cables and jointing sleeves fitted. <p>Used for replacing damaged connectors in the truck.</p>

Tool

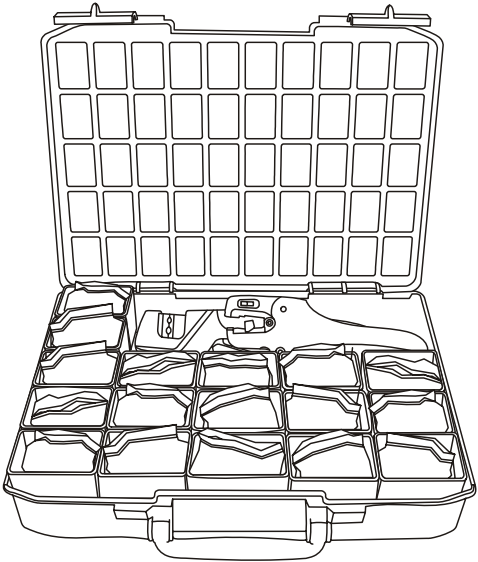
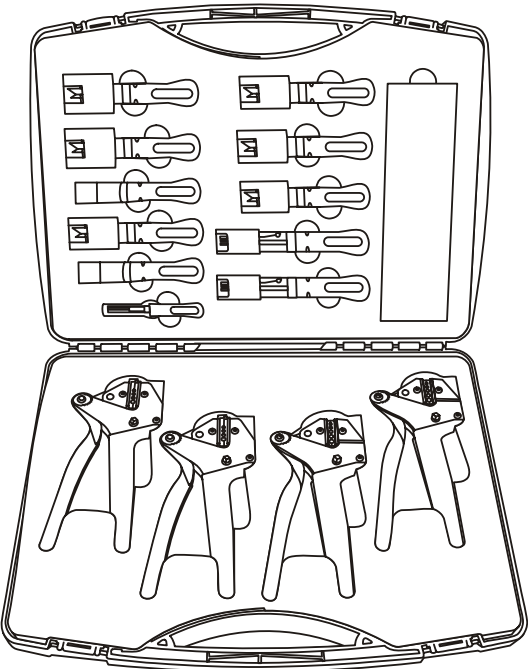
MQS contacts

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Tool	Number	Use
	257842	<p>MQS assorted box. Used for "Full MQS 257843 tool box".</p> <p>The assorted box contains:</p> <ul style="list-style-type: none"> 200 sleeves, 0.2–0.5 mm² 200 SWS sleeves, 0.2–0.5 mm² 400 SWS sleeves, 0.5–0.75 mm² 100 "clean body" sleeves, 0.5–0.75 mm² 200 SWS pins, 0.2–0.5 mm² 400 SWS pins, 0.5–0.75 mm² 1200 seals 200 dummy plugs
	257843	<p>Full MQS tool box.</p> <p>Contains 4 pliers with tools:</p> <ul style="list-style-type: none"> MQS SWS 0.25–0.5 mm² MQS SWS 0.5–0.75 mm² MQS Std. & "clean body" 0.25–0.5 mm² MQS Std. & "clean body" 0.5–0.75 mm² <p>Extraction tools for 2-, 3-, 4-, 6-, 8- and 12-pole male and female connectors.</p>

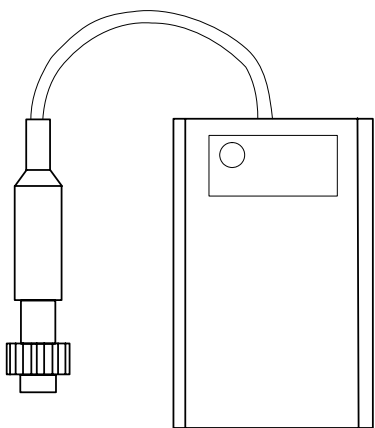
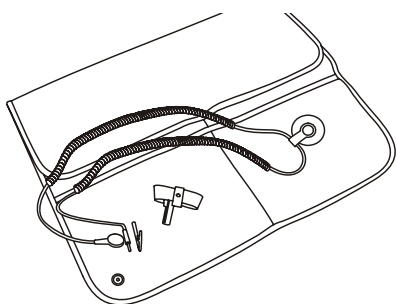
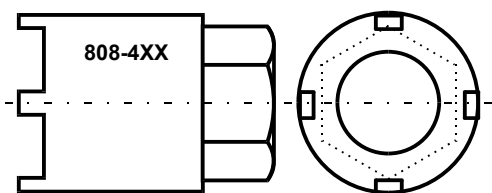
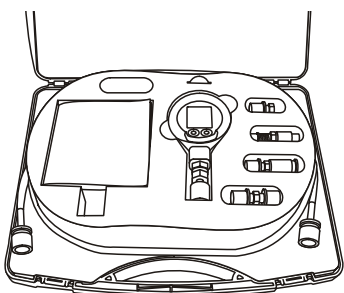
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21.4 Other tools

Tool	Number	Use
	156263	Service instrument (CAN)
		Anti-static mat for electronic work
	808-413	Socket for support arm wheel
	219730	Pressure measurement for hydraulics

Tool

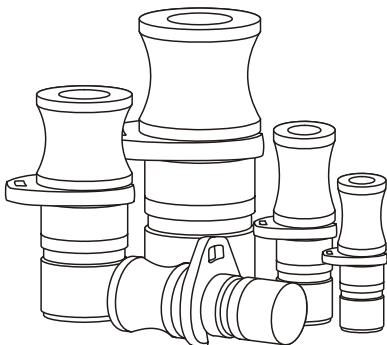

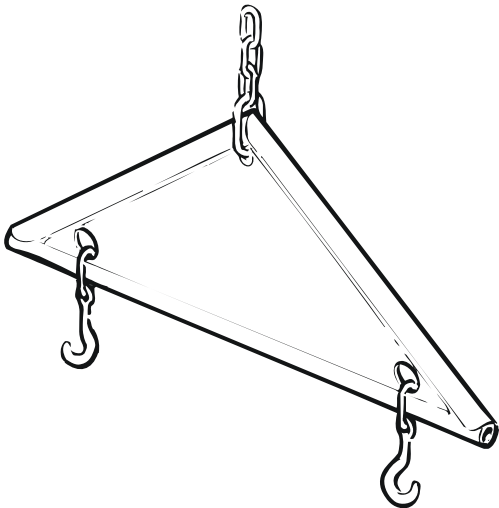
Other tools

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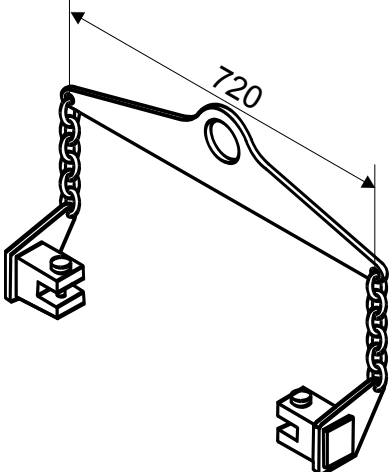
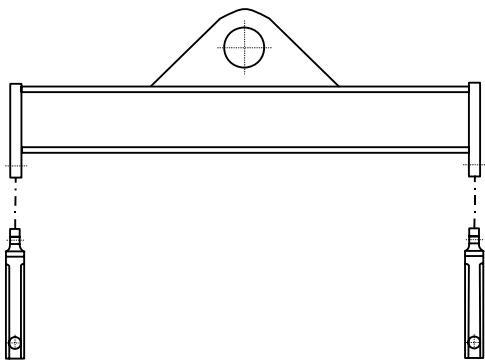
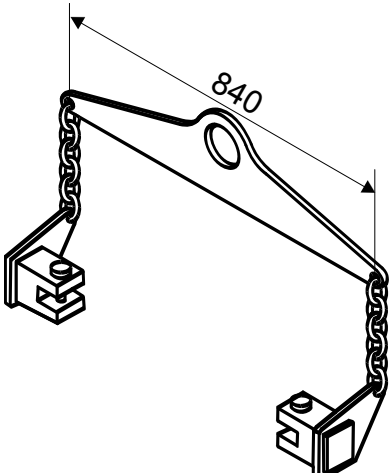
Tool	Number	Use
	1/4" — 254526 3/8" — 254527 1/2" — 254528	Plugs (male part) for valves with WEO type quick change connector
	1/4" — 254529 3/8" — 254530 1/2" — 254531	Plugs (female part) for hydraulic hoses with WEO type quick change connector
	11-999-8	Lifting tool for battery 1,500 kg max.

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Tool	Number	Use
	11-1242	Lifting tool for mast
	11-1091	Lifting tool for mast
	11-1133/2	Lifting tool for mast

Tool

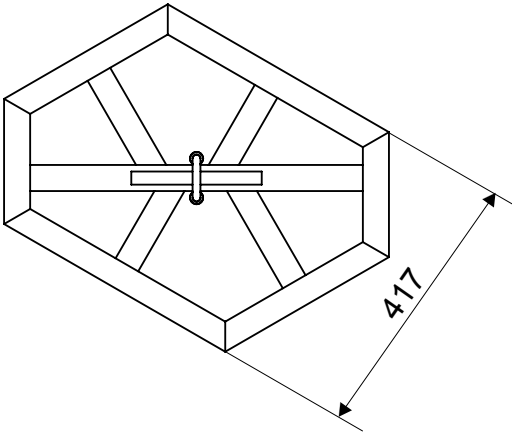
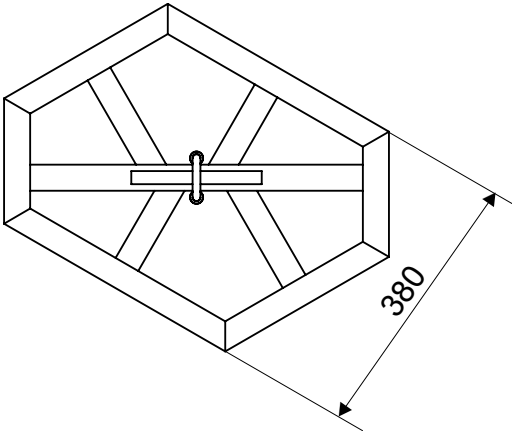
Other tools

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Tool	Number	Use
	11-1020	Lifting tool for mast runner
	11-1021	Lifting tool for mast runner

Appendix “Service data and grease specifications”

General tightening torques

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22 – Appendix “Service data and grease specifications”

22.1 General tightening torques

Millimetre threads M3 to M24.

The tables apply under good conditions, e.g. steel against steel.

22.1.1 Galvanised non-oiled bolts

Tightening torque (Nm)			
	Strength class:		
	8.8	10.9	12.9
M3	1.1	1.6	2.0
M4	2.8	3.8	4.7
M5	5.5	7.7	9.3
M6	9.5	13	16
M8	23	32	38
M10	45	62	76
M12	78	109	130
M14	123	174	208
M16	189	266	320
M20	370	519	623
M24	638	898	1075

Appendix “Service data and grease specifications”

General tightening torques

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22.1.2 Untreated oiled bolts

Tightening torque (Nm)			
	Strength class:		
	8.8	10.9	12.9
M3	1.2	1.7	2.1
M4	2.9	4.0	4.9
M5	5.7	8.1	9.7
M6	9.8	14	17
M8	24	33	40
M10	47	65	79
M12	81	114	136
M14	128	181	217
M16	197	277	333
M20	385	541	649
M24	665	935	1120

IMPORTANT

Experience has shown that if you adjust the torque wrench to the values for untreated bolts, you will also achieve the correct torque value for galvanised bolts. Do not tighten more than the values set out in the table otherwise the bolts may be destroyed.

Appendix “Service data and grease specifications”

Oil and grease specifications

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22.2 Oil and grease specifications

Type of lubricant		Specification		Applications
		> -15 °C	< -15 °C	
A	Grease	S213366 Q8 Rubens WB	S213366 Q8 Rubens WB	Bearings and bushings
B	Hydraulic fluid	ISO-VG32	ISO-VG27.5	Hydraulic system
C	Transmission oil	Hypoid oil SAE 75W-90 Class API-GL5		Gears
D	Grease	See table below	See table below	Chains
E	Grease	Grafloscon A-G1 (Klüber)	Grafloscon A-G1 (Klüber)	Gear ring
F	Grease	S213366 Q8 Rubens WB	S213366 Q8 Rubens WB	Mast

Pos	Ambient temperature	Viscosity class	Recommended products*
D	> -40 °C < -30 °C	VG 15	Klüberoil 4UH 1-15, Klüber Lubrication
D	> -30 °C < +5 °C	VG 68	Klüberoil 4UH 1-68N, Klüber Lubrication Anticorit LBO 160 TT, Fuchs DEA
D	> +5 °C < +45 °C	VG 150	Klüberoil 4UH 1-150N, Klüber Lubrication Anticorit LBO 160, Fuchs DEA Rexoil, Rexnord Kette
D	> +45 °C < +80 °C	VG 220	Klüberoil 4UH 1-220N, Klüber Lubrication

* Equivalent products from another manufacturer may be used

Appendix “Service data and grease specifications”

Oil and grease specifications

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23 – Technical data

Table 2: Technical data		
Model	RRE 140 RRE 160	RRE 180 RRE 250
Drive motor		
Type	TSA170-140-072	TSA170-200-106
Output, kW	11.6	15.0
Transmission/gear		
Designation	GK25	GK30
Gear ratio	20.2:1	22.4:1
Oil volume, litres	3.3	4.6
Oil type	Hypoid oil	
Viscosity class, ambient temperature + 40 to –30 °C	SAE 75W-90 API GL 5	
Wheel and brakes		
Parking brake, nominal braking torque	90 Nm	
nominal play	0.3 ± 0.1 mm	
maximum play	0.50 mm	
minimum thickness for the friction disc	10.5 mm	
coil resistance	48 ohms at 20 °C	
Support arm brake, nominal braking torque	1000 Nm	
number of inner discs	3 items	
number of outer discs	5 items	
Drive wheel, diameter x width, mm	-	-
Support arm wheel, diameter x width, mm	-	-
Maximum weight on support arm wheel without load/with load (kg)	-	-
Maximum weight on drive wheel without load/with load (kg)	-	-
Maximum wheel pressure, support arm (MPa)	-	-
Maximum wheel pressure, drive (MPa)	-	-

Technical data

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Table 2: Technical data		
Model	RRE 140 RRE 160	RRE 180 RRE 250
Hydraulic system		
Pump motor, type	TSA170-140-072	TSA170-200-106
Output, kW	11.6	15.0
Pump displacement	16 cc	19 cc
Tank volume, litres	25	25
Oil type:		
Normal temperature	ISO-VG32	ISO-VG32
<-15°	ISO-VG27.5	ISO-VG27.5
Hydraulic pressure		
Overflow pressure, bar	250	250
Pressure limitation tilt/extra function/ cabin tilt, bar	150	150
Steering motor		
Designation	247454-001	208014-003
Output, continual, max W	300	400
Fuses		
F1, Drive motor	160 A	200 A
F3, Pump motor	250 A	325 A
F60, ESO circuit	3 A	3 A
F61, Main fuse MCU [A5]	7.5 A	7.5 A
F62, Main fuse CID [A1]	3 A	3 A
F63, Main fuse LID [P6]	7.5 A	7.5 A
F64, Steering servo EPS [A2]	3 A	3 A
F65, GFU (option)	5 A	5 A
F66, Converter [T5], [T6]	7.5 A	7.5 A
F69, Extra equipment	10 A	10 A
F71, MCU [A5]	7.5 A	7.5 A
F72, Steering motor EPS [M6]	30 A	30 A
F73, Controls [T1], [A5]	7.5 A	7.5 A
F74, Key relay [A1], [A5]	3 A	3 A
F75, Working light (option)	10 A	10 A

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Table 2: Technical data

Model	RRE 140 RRE 160	RRE 180 RRE 250
F76, Converter [T3] (option)	7.5 A	7.5 A
F77, Seat heater (option)	10 A	10 A
F90, Cabin heater (cold store cabin)	100 A	100 A
F91, Heater control (cold store cabin)	7.5 A	7.5 A
F92, Heater element (cold store cabin)	25 A	25 A
F93, Heater element (cold store cabin)	25 A	25 A
F94, Heater element (cold store cabin)	25 A	25 A
F95, Heater element (cold store cabin)	25 A	25 A
Batteries		
Capacity, Ah	450 – 750	450 – 900
Driving speed, km/h		
Without support arm brake, drive wheel direction, laden/unladen (km/h)	10	10
Without support arm brake, fork direction, laden/unladen (km/h)	7	7
With support arm brake, drive wheel direction, laden/unladen (km/h)	14	14
With support arm brake, fork direction, laden/unladen (km/h)	Unladen: 10 > 1000 kg: 8	Unladen: 10 > 1000 kg: 8

Technical data

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